Popular Astronomy

Vol. XLVI, No. 10 DECEMBER, 1938 Whole No. 460

The International Astronomical Union Meeting at Stockholm, Sweden, 1938 August 3-10

By FREDERICK C. LEONARD

Through the courtesy of the Swedish Government, the House of Parliament (*Riksdagshuset*) in Stockholm served as the headquarters for the meeting of the International Astronomical Union, 1938 August 3-10. In this building, both the general assemblies and the sessions of the various commissions were held. One can hardly imagine such things occurring in the Capitol at Washington or in Westminster Palace at London!

The meeting opened at 11:00 A.M. on Wednesday, August 3, with the inaugural ceremony in the Concert Hall (*Konserthuset*), an imposing structure of "modernistic" architecture, quite in keeping with the general atmosphere of Stockholm, which appears to be more up to date in this respect than any other European city with which I am acquainted. At the opening ceremony, addresses of welcome were delivered by the Minister of Justice, *Statsrådet* K. G. Westman, the Chairman of the Swedish National Committee on Astronomy, Professor H. von Zeipel, the President of the Royal Swedish Academy of Science, Professor B. Lindblad, and the President of the International Astronomical Union, Professor E. Esclangon, and selections were rendered by Eric Bengtson's Orchestra.

At 2:30 P.M., the first general assembly convened, at which speeches were made by the President and other officers of the Union, and routine business was transacted. At 8:00 o'clock in the evening, a *souper* was given the delegates and their accompanying ladies by the Municipality of Stockholm, in the new and magnificent City Hall (*Stadshuset*). This building is certainly the most striking, if not also the most beautiful public edifice in the capital. The company assembled in the *"Blå Hallen,"* and thence was conducted into the *"Gyllene Salen,"* where the luxurious *souper* was served with customary Swedish hospitality. At the end of the repast, which, with occasional speeches from the head table, lasted most of the evening, the guests availed themselves of an invitation to wander through the splendid Hall, and dancing was provided for those who wished to participate.

On Thursday morning, August 4, the following commissions held their initial meetings: (4) Ephemerides, (8) Meridian Astronomy, and (20) Minor Planets *etc.* (together); (5) Bibliography; (12) Solar

Radiation and Solar Spectroscopy; (22) Meteors *etc.*; (24) Stellar Parallaxes and Proper Motions; (10) Sunspots and Characteristic Figures; (14) Wavelengths; (16) Planets and Comets (Physical); (33) Stellar Statistics; (13) Solar Eclipses; (17) Lunar Nomenclature; (19) Variation of Latitude; (23) *Carte du Ciel;* and (28) Nebulae.

In the afternoon, a reception was given in the spacious Royal Palace, across a narrow canal from the tiny island on which the House of Parliament is located. The reception was intended to be held by His Majesty the King of Sweden, but as the King was unable to be in Stockholm at the time and the Crown Prince was indisposed, the eldest son of the Crown Prince, Prince Gustafus Adolphus, did the honors in place of his grandfather.

On Friday morning, August 5, the following commissions met: (3) Notations; (18) Longitudes; (27) Variable Stars; (29) Stellar Spectra; (6) Telegrams; (8) Meridian Astronomy; (20) Minor Planets *etc.*; (25) Stellar Photometry; (30) Radial Velocities; (9) Instruments; (15) Comets; (31) *Bureau de l'Heure*; and (32) Selected Areas.

In the afternoon, an excursion was made to Saltsjöbaden, a remote suburb of Stockholm, by special train, leaving from the Saltsjöbanans station in the city. After arriving at Saltsjöbaden, the party was entertained at luncheon by the Swedish National Committee on Astronomy at the "Grand Restaurant Saltsjöbaden." The luncheon in no way belied the name of the restaurant! After luncheon, the company made its way, by an uphill but easy climb of about a mile, to the extensive grounds of the Stockholm Observatory of the Swedish National Academy of Science, of which Dr. Lindblad is Director. There the visitors had an opportunity to inspect the new Observatory, all parts of which were thrown open for their examination, and they were treated to light refreshments by Dr. and Mrs. Lindblad. There too they gathered for a group photograph, taken in front of the main entrance to the Observatory.

The view from the Observatory is superb; it is faintly reminiscent of the outlook from the Yerkes Observatory, on the north bluff of Lake Geneva, in Wisconsin, and more remindful, perhaps, of the prospect from the Dominion Astrophysical Observatory at Victoria, Vancouver Island, British Columbia. The Stockholm Observatory itself, with its several new and large telescopes and all its up-to-date appointments, is a model of neatness and excellence. After a most interesting and profitable afternoon spent at this leading Observatory of Sweden, the visitors returned downhill to the railway station and departed at 7:00 P.M. by special train for Stockholm.

On Saturday morning, August 6, a combined meeting of Commissions (11) Chromospheric Phenomena, (12) Solar Radiation and Solar Spectroscopy, (13) Solar Eclipses, (28) Nebulae, (29) Stellar Spectra, and (36) Spectrophotometry, called for a discussion on spectral "Emis-

sion Lines," was open to all members of the Union and was attended by many. At this session, presided over by Sir Arthur Eddington, introductory talks on various phases of the matter were made by Professor H. N. Russell, on a "General Review of the Subject," Dr. H. Zanstra, on "Emission Lines in Nebulae and Novae," Professor D. H. Menzel, on the "Chromosphere and Corona," and Dr. P. W. Merrill, on "Emission Lines in Stellar Spectra"; and Dr. B. Lyot showed and described a remarkable motion-picture film of prominences and the corona, obtained without an eclipse. Simultaneously, other commissions met for the second time.

FIGURE 1

THE HOUSE OF PARLIAMENT (RIKSDAGSHUSET), STOCKHOLM, THE HEADQUARTERS OF THE I. A. U. MEETING

In the early afternoon, Commissions (11) Chromospheric Phenomena; (26) Double Stars; and (35) Stellar Constitution, held meetings, after which a large party of the delegates and their guests visited the Planetarium near "Skansen," and attended a lecture-demonstration by Dr. N. V. E. Nordenmark on the topic of *"Le ciel étoilé du Nord."* Being familiar with such demonstrations in my own city of Los Angeles, as well as in Chicago and New York, I could not help being struck by the unavoidable sameness of these performances everywhere, even though this lecture was in French! The group then had tea at the "Solliden" restaurant and subsequently visited the open-air cultural Museum "Skansen," through a large part of which the company was conducted by young-women guides whose ability to speak Swedish, English, French, and German, won the admiration of everybody who was not so linguistically accomplished! Following the tour of the open-

air Museum, a performance of national dances by artists attired in native costumes was given for the special benefit of the party at "Bollnästorget."

In the evening of this busy day, a combined meeting of Commission (33) Stellar Statistics, together with Commissions (8) Meridian Astronomy, (23) *Carte du Ciel,* (24) Stellar Parallaxes and Proper Motions, (25) Stellar Photometry, (27) Variable Stars, (28) Nebulae, (29) Stellar Spectra, (30) Radial Velocities, and (32) Selected Areas, was open to all members of the Union and held under the chairmanship of Dr. Lindblad, the President of Commission (33). This session was called for the purpose of discussing the significance of the various branches of stellar astronomy in relation to the problem of galactic structure. Introductory talks were made by Professor B. J. Bok, on "Star Counts," Professor B. Lindblad, on "Spectral Types and the Distribution of Special Objects," and Professor H. Shapley, on "Absorption Phenomena as Inferred from the Distribution of Extragalactic Objects." Much discussion from the floor followed the addresses of this important symposium.

On Sunday, August 7, an excursion into the lovely Archipelago of Stockholm was made by a large number of the delegates and others on the specially chartered steamship *Brynhild,* which sailed from the "Skeppsbron" wharf near the Royal Palace in Stockholm at 11:00 A.M., and returned thereto in the early evening. Luncheon was served on board, on open deck. This delightful cruise took the passengers within sight of, if not actually into, the Baltic Sea, and was one of the most enjoyable episodes of a program filled with all kinds of unusual entertainments. For those who did not care to take the water trip but preferred a land excursion, the regular sightseeing tour to Drottningholm Castle was recommended.

On Monday, August 8, a journey was made to Uppsala and Old Uppsala. Departure, at 9:25 A.M., was by special train from the Central Station in Stockholm. The party arrived at Uppsala at 10:15 A.M., and visited, in all too rapid succession, because of the limited amount of available time, the fine old Cathedral with its numerous historical monuments, the Uppsala Observatory with its many instruments, both old and new, and the Library with its famous collection of manuscripts and documents. At the conclusion of this tour, a luncheon was given the company by the Uppsala University, the Municipality of Uppsala, and the Swedish National Committee on Astronomy, in Uppsala Castle. Like all the other repasts to which the party was treated, this luncheon was a sumptuous affair, and, in the romantic surroundings of a medieval castle, seemed more like a banquet than an ordinary meal! At 3:40 P.M., the group departed by special train for Old Uppsala, which is situated at a distance of only a few miles from Uppsala. At Old Uppsala, the party, under the direction of a competent guide, visited the ancient burial mounds, of great archeological interest, and the old parish church, both

of which features the guide took pains to explain in detail. Finally the company left Old Uppsala by train at 5:10 P.M., and returned to Stockholm, after another full day, at 6:10 P.M.

FIGURE 2

THE CITY HALL (STADSHUSET), STOCKHOLM, where a *souper* was given by invitation of the Municipality of Stockholm on August 3

On Tuesday morning, August 9, was held a specially scheduled meeting of Commission (36) Spectrophotometry, presided over by Dr. M. Minnaert, at which Professor A. Unsöld spoke on "The Continuous Absorption in Stellar Atmospheres," and Dr. R. O. Redman introduced the

subject of "Errors in the Measurement of Line Profiles." Other commissions met at the same time that morning and likewise in the early afternoon.

Following the commission meetings in the afternoon, an exhibition of solar films was given in open session. At this assembly, Captain J. F. Hellweg and his son, Mr. V. Hellweg, showed a motion-picture film and lantern slides illustrating a recent eclipse expedition of the United States Naval Observatory, and Dr. B. Lyot, by special request, repeated the projection of his extraordinary film of prominences and the corona. Judged by the spontaneous applause with which this film was received on both of the occasions when it was exhibited and by the demand for its second showing, it might well be regarded as the scientific highlight of the program.

That evening the entire party of delegates and guests was "dined, wined, and fêted" at an elaborate banquet and dance, given at the "Hasselbacken" restaurant, near "Skansen," by the Swedish National Committee on Astronomy. At the close of the meal, several after-dinner speeches were made, of which obviously the most popular and also the most widely understood by the polyglot assemblage, was that of Professor F. J. M. Stratton. This speech he delivered, first in English, and then in half a dozen other languages! The banquet and dance, which did not terminate for some members of the company until the "wee sma' hours" of the morning, concluded the festivities of this literally eventful meeting.

The last day, Wednesday, August 10, was given up, both forenoon and afternoon, to general assemblies, at which reports were read, resolutions were adopted, officers for the ensuing term, 1938-41, were elected and installed, the personnel for the next three years of the numerous commissions and sub-commissions (including that of a new commission on interstellar matter, under the presidency of Dr. J. Stebbins) was announced, other business was transacted, and farewell speeches were made. It is not my purpose to dilate on the details, or systematically to record the minutes, of these last two sessions, as such information can be found in the official report of the meeting. Suffice it to mention here only the most important features of these two concluding assemblies, mainly the final one.

The election of Sir Arthur Eddington as President of the Union for the years 1938-41 was announced at the last (afternoon) assembly, and his "inaugural address" was read in his absence by the presiding Vice-President, Dr. W. S. Adams. Sir Arthur had been obliged to leave Stockholm a day or two before the close of the meeting, in order to arrive home at Cambridge, England, in time for the opening of the convention of the British Association for the Advancement of Science, which had been scheduled to take place there a few days after the end of the Union meeting in Stockholm. Addresses of farewell and in appreciation of the many courtesies extended during the period of the

meeting, were delivered, on behalf of the Union members, by Professor A. O. Leuschner, and, for the ladies, by one of their number, who, at the conclusion of her speech, gracefully presented to Dr. and Mrs. B. Lindblad and to Dr. and Mrs. Y. Öhman, each a little mememto of the occasion. Finally, it was stated that the next meeting of the Union—which is to occur in 1941—will be held in Switzerland, probably at Zürich or Geneva; and, at an advanced hour of the afternoon, the meeting adjourned, *sine die*, with the delegates and guests dispersing to their homes in thirty countries!

It may be interesting to note that, of the addresses which I heard, about two-thirds were in English, a third was in French—the President (M. Esclangon) was French—a few were in German, and *none* was in Swedish or any other language. If an auditor was equipped, then, with a working knowledge of English and French, he was prepared to comprehend at least the language of nearly all of the speeches delivered at this meeting.

According to the printed program, the various nations adhering to the Union sent the following official delegates (most of them members of the Union) to the meeting. The first number given in connection with the name of each country is the number of its delegates, and the second, that of their accompanying guests.

BELGIUM: 12, 4
S. Arend
J. Cox
E. Delporte
J. Delvosal
F. de Roy
E. Merlin
F. Moreau
F. E. Nisoli
J. Pelseneer
P. Swings
E. Vandekerkhove
H. L. Vanderlinden

BULGARIA: 1, 0
N. Boneff

CANADA: 4, 6
C. A. Chant
W. E. Harper
F. S. Hogg
J. S. Plaskett

CZECHOSLOVAKIA: 11, 8
K. Dusl
E. F. Freundlich
V. Guth
W. W. Heinrich
Z. Kopal
F. Link
J. Madar
J. M. Mohr
V. Nechvíle
H. Slouka
J. Svoboda

DENMARK: 8, 5
R. Andersen
D. la Cour
J. P. Möller
A. V. Nielsen
N. E. Nörlund
B. Strömgren
E. Strömgren
Miss J. Vinter Hansen

EGYPT: 1, 1
M. R. Madwar

ESTHONIA: 1, 1
E. Öpik

FINLAND: 3, 1
R. Furuhjelm
H. O. Grönstrand
J. Tuominen

FRANCE: 18, 8
J. Baillaud
F. Baldet
D. Barbier
D. Chalonge
H. Chrétien
A. Couder
L. d'Azambuja
H. Deslandres
E. Esclangon
G. Fayet
Mme. C. G. Flammarion
H. Grouiller
A. Lambert
B. Lyot
H. Mineur
G. Perrier
M. A. Schmitt
N. Stoyko

GERMANY: 11, 4
F. Becker
H. Jehle
H. Ludendorff
F. Schembor
E. Schoenberg
R. Schorr
P. ten Bruggencate
O. Thomas
A. Unsöld
E. von der Pahlen
H. von Klüber

GREAT BRITAIN: 45, 24
R. d'E. Atkinson
A. Beer
H. Brück
C. P. Butler
J. A. Carroll
L. S. Chapman
G. L. Clark
L. J. Comrie
A. C. D. Crommelin
C. R. Davidson
H. Dingle
J. C. Dobbie
A. S. Eddington
D. S. Evans

W. M. H. Greaves
W. Hall
F. J. Hargreaves
A. R. Hinks
W. B. Housman
J. de G. Hunter
H. S. Jones
A. E. Levin
W. M. Lindley
E. M. Lindsay
W. H. McCrea
W. Moss
H. W. Newton
T. E. R. Phillips
H. H. Plaskett
R. O. Redman
J. H. Reynolds
A. H. Rosenthal
J. P. Rowland
D. H. Sadler
W. H. Steavenson
F. J. M. Stratton
W. S. Tai
A. D. Thackerav
R. Waterfield
G. J. Whitrow
H. S. L. Winterbotham
W. M. Witchell
J. C. Wood
R. v. d. R. Woolley
H. Zanstra

GREECE: 1, 0
S. M. Plakidis

HOLLAND: 16, 7
A. Blaauw
J. G. Ferwerda
E. Hertzsprung
W. J. Luyten
W. C. Martin
M. Minnaert
J. H. Oort
P. T. Oosterhoff
L. Plaut
Miss E. Schuurman
K. A. Strand
J. Uitterdijk
H. van Gent
G. van Herk
P. J. van Rhijn
F. A. Vening-Meinesz

HUNGARY: 1, 0
K. Lassovszky

INDIA (BRITISH): 1, 1
T. Royds

ITALY: 7, 3
G. Abetti
L. Carnera
G. Cecchini
E. Loreta
M. Maggini
G. Silva
F. Zagar

JAPAN: 2, 0
Y. Hagihara
I. Yamamoto

JUGOSLAVIA: 1, 0
M. J. Terzitch

LITHUANIA: 1, 1
P. Slavenas

NORWAY: 8, 4
C. C. Christiansen
K. Lous
G. Randers
S. Rosseland
G. Steensholt
C. Störmer
L. Vegard
J. Wasiutynski

POLAND: 10, 2
T. Banachiewicz
M. Bielicki
J. Gadomski
Miss W. Iwanowska
M. Kamienski
F. Kepinski
F. Koebcke
J. Krassowski
S. Piotrowski
E. Rybka

ROMANIA: 4, 1
G. Bratu
N. Donitch
C. Parvulesco
V. G. Siadbey

SOUTH AFRICA: 2, 2
J. Jackson
H. E. Wood

SPAIN: 3, 1
P. Carrasco
L. Rodés
P. M. Ryves

SWEDEN: 42, 22
O. Åkesson
H. Alfvén
A. Ångström
S. Asklöf
B. Asplind
T. E. Aurén
F. Berglund
Ö. Bergstrand
K. Bohlin
P. Collinder
A. Corlin
C. G. Danver
G. Dyfverman
B. Edlén
W. Gyllenberg
S. Holm
E. Johansson
H. Köhler
B. Lindblad
A. Lindstedt
K. Lundmark
C. Lönnqvist
G. Malmquist
N. V. E. Nordenmark
H. Nordström
J. Ohlsson
Y. Öhman
Miss F. Palmér
H. Petersson
H. Pleijel
J. Ramberg
K. D. P. Rosén
A. Roth
T. Rubin
C. Schalén
T. Setterberg
G. Slettenmark
E. Stenquist
N. Tamm
H. von Zeipel
Å. Wallenquist
G. Wernberg

SWITZERLAND: 5, 1
W. Brunner
E. Guyot
O. Lütschg
S. Mauderli
M. Waldmeier

U. S. S. R.: 1, 0
L. J. Semenof

UNITED STATES OF AMERICA: 60, 32
C. G. Abbot
W. S. Adams
W. Baade
J. G. Baker
R. H. Baker
B. J. Bok
Mrs. P. F. Bok
B. Boss
Miss C. Boyd
J. Boyd
H. E. Burton
Miss M. R. Calvert
Miss A. J. Cannon
Miss E. R. Cornwall
Miss D. N. Davis
Miss H. W. Dodson
C. W. Elmer
Miss A. H. Farnsworth

L. Goldberg
L. C. Green
W. K. Green
J. S. Hall
G. R. Harrison
Miss M. Harwood
J. F. Hellweg
V. Hellweg
Miss D. Hoffleit
M. L. Humason
T. S. Jacobsen
H. M. Jeffers
Miss E. Jones
Miss R. Jones
M. S. Kovalenko
G. P. Kuiper
W. D. Lambert
F. C. Leonard
A. O. Leuschner
N. Mayall
W. F. Meggers
D. H. Menzel
P. W. Merrill
S. A. Mitchell
Miss J. Mohr
J. Robertson
H. N. Russell
J. Schilt
M. Schwarzschild
H. Shapley
B. W. Sitterly
Mrs. C. E. M. Sitterly
F. Slocum
Miss L. T. Slocum
J. Stebbins
T. E. Sterne
J. Stokley
G. Strömberg
Miss H. H. Swope
A. van Maanen
A. N. Vyssotsky
R. Wildt

VATICAN CITY: 2, 0
J. W. Stein
M. Tibor

Total number of delegates: 282; of guests: 139; of persons, both delegates and guests, who were officially in attendance at the meeting and for whom accommodations and entertainment were provided: 421.

I cannot conclude this account without expressing the appreciation, which I believe was shared by all the visitors alike, of the excellent manner in which every detail was administered by our hosts, Dr. Lindblad, Dr. Öhman, and the other members of the Swedish National Committee on Astronomy, for our comfort, convenience, and pleasure. Both the formal and scientific features of the program and the splendid entertainments which were so liberally provided by the Swedish Government, the Municipalities of Stockholm and Uppsala, the Swedish National Committee on Astronomy, and the several institutions which kept open house at Stockholm, Saltsjöbaden, Uppsala, and Old Uppsala, all took place without a single untoward incident. It was, I think, the general consensus of opinion that Stockholm, called sometimes "the Venice of the North," is an unusually attractive city and a singularly happy choice for an international gathering of this kind. Its color, cleanness, and modernity are especially appealing, and the charm of its lovely—almost unique—setting, interspersed with lagoons, canals, and islands, is difficult adequately to describe. These things combined to make the Stockholm meeting an uncommon success and our sojourn in Sweden an experience which we shall gratefully remember.

DEPARTMENT OF ASTRONOMY, UNIVERSITY OF CALIFORNIA,
LOS ANGELES, 1938 OCTOBER 29

The Benld Meteorite

(Illinois No. 2)[1]

By BEN HUR WILSON

Someone once approached the late Dr. O. C. Farrington, noted meteorite authority and curator of the Field Museum of Natural History, calling his attention to a report that a meteorite had fallen in Illinois, and he was said to have replied naively, "That just isn't possible, no meteorite was ever known to fall in the State of Illinois."

Strangely enough, up until 1927, this remark was absolutely true. In every state adjoining Illinois, there had been a number of falls, of more or less importance, several of which came only a few miles from her borders. But alas! Poor meteorite-shy Illinois, in spite of the fact that there reposed in the halls of the Field Museum, one of the world's largest and finest collections of meteorites, ironically had not a single native specimen of her own to exhibit.

However, on the afternoon of July 13, 1927,[2] at about 1:00 P.M., this unique situation ended, for at that moment a meteorite, the first of authentic record in the history of Illinois, showered down to earth in the vicinity of Tilden, some forty miles southeast of St. Louis. This meteor exploded in the atmosphere with deafening detonations, and at least four stones weighing 110, 46, 9, and one less than a pound, respectively, were subsequently recovered and preserved for science.

The second authentic fall for Illinois, which is to be the subject of this report, did not occur until more than eleven years later, when on Thursday, September 29, 1938, at about 9:00 A.M., in the south edge of the town of Benld,[3] Macoupin County, a small stony-iron meteorite came crashing out of the battlements of heaven, aimed apparently with the precision of a crack artilleryman, not only striking but penetrating the roof of a garage, as well as the car inside, thereby creating a situation, which, in several respects, is believed to be unique in the annals of meteoric phenomena. This spot being located some forty miles northeast of St. Louis and sixty-five miles almost due north of Tilden, it would seem that the southern part is to hold the monopoly on Illinois falls.

The first intimation the writer had of this fall occurred on Saturday evening, October 1, when on returning home rather late his attention was called to a report that was heard over Tod Hunter's 10:30 P.M. radio news-broadcast, over station WBBM, of a meteorite hitting a garage in southern Illinois, passing completely through the roof of the building and the car inside it, and burying itself in the ground. It was afterwards learned that a like report was broadcast over station WLS about 6:30 P.M. on the same evening.

Having well in mind a similar story in which a car was said to have been struck and penetrated by a meteorite in nearby northern Indiana only a few years previous, which had been widely publicized but later

proved to be only a "dud," little immediate thought was given the matter. When, however, in reading the Sunday morning paper (*Joliet Herald-News*) the next forenoon, my eye caught the following brief news item, tucked inconspicuously away among advertising matter on page 3, my interest was at once keenly aroused.

SHOULD HAVE HAD METEORITE INSURANCE

(By Associated Press)

Benld, Ill., Oct. 1.—When Edward McCain went to his garage to get his car, he found holes through the garage roof and through the top and body of the car. Investigating, he said he discovered a four-inch meteorite buried in the ground beneath the machine.

FIGURE 1

VIEW OF BENLD METEORITE SHOWING CHARACTERISTIC THUMB MARKINGS, AND BLACK FUSED COATING.

Despite the fact that the item sounded fantastic, there was also something about it which seemed to ring true. Its mere simplicity suggested that perhaps there might be more to it than a newspaper reporter's publicity stunt. Accordingly, a brief conference was held over the telephone with my friend, Frank M. Preucil, Jr., fellow-member and "*Coordinator of Research*" of the Joliet Astronomical Society, and further investigation was decided upon. It was agreed that Mr. Preucil should communicate with the owner, and that the writer should enter into cor-

respondence with the local High School Principal, with the object of first determining, if possible, the authenticity of the fall, before venturing on a five hundred mile automobile trip to make an investigation which we had a feeling might only prove futile. In other words we were keeping our fingers crossed.

Letters were sent out to both parties promptly, and in due time Mr. Preucil received the following reply from Mr. McCain:

Benld, Ill., Oct. 12.

Mr. Preucil: There was a meteorite fell through our garage and through the top of car and landed in springs of cushion on Thursday morning about 9 o'clock, Sept. 29.

It is 4 by 3 by 2¾ (inches) thick. It weighs 4 pounds. It is black, there was no flash but sounded like an airoplane. Come any day have a look at it. I live south of high school.

Ed McCain, Benld, Ill.

Soon thereafter the writer received the following communication from Mr. F. A. Bertetti, Principal, of the Benld Township High School.

Benld, Ill., October 14, 1938.

Dear Mr. Wilson:

Yes, it was a meteorite all right. It weighs about 5 pounds and fell within two blocks of our school. It is about a 5-inch cube and has a black dull glaze on the outside caused by the intense heat. It has a number of shallow pockets on the outside indicating that some more fusible material burned out on the way down. It seems to be a mixture of iron and dull grey stone on the inside. We used it for demonstration purposes in our physical Geography class.

Sincerely yours,

FAB:JGD F. A. Bertetti.

Conflicting duties prevented us from making the trip over the first weekend, and so it was not until Saturday, October 22, that it was possible for us to go to Benld to carry out our investigation. In the meantime, fearing that the stone might be broken up or otherwise mutilated, as in previous instances where the owners had pulverized their prize in search of gold or some other valuable mineral, thereby utterly destroying objects of great scientific value, letters were sent explaining that we were expecting to come soon to investigate the fall, and asking that the stone be preserved intact and unharmed pending our arrival. We are glad to report that such advice was needless, for we found that the owner fully appreciated the importance of the meteorite both for its sentimental and scientific value, and had guarded it most zealously.

Arrived on the scene the preceding evening (Friday), still harboring some misgivings regarding the validity of the fall, no doubt having Farrington's words in mind, I expected to communicate with Preucil telling him not to make the trip should the stone prove to be "bogus." I went at once to call on Principal Bertetti, who had kindly volunteered to accompany and introduce me to the McCains, whose home, being in the outskirts of town, would have been most difficult for a perfect stranger, unfamiliar with the lay of the land, to have found after dark.

He went with me immediately and arriving at McCains entered the house by way of the kitchen, remaining there while Mrs. McCain went into the front part of the house to "fetch the stone" from its hiding place. The moment I "laid eyes on it," I saw at once that here was a genuine find, and a closer examination revealed it to be as beautiful a little meteorite as I have ever seen. After a short chat, arrangements were made to return the following forenoon for a complete investigation of all of the facts concerning the fall. I then retired to the hotel with a

FIGURE 2

VIEW OF BENLD METEORITE SHOWING SMALL FRACTURE MADE IN STRIKING, EXPOSING INTERIOR AND THICKNESS OF CRUST.

light heart and a keen anticipation of the pleasure which was to be mine on the morrow. For nearly twenty years, I have been vainly hoping to catch up with a meteorite and to be the first to investigate and report on a fall, and at last I felt that my hopes were to be realized. Next to actually witnessing a fall with one's own eyes, this is the greatest ambition of every meteorite investigator.

Resuming our investigation early the following morning, we learned that so far as is known at the present time no one actually witnessed the passage of the meteorite through the atmosphere, although Mrs. Carl C. Crum, who was working in the rear part of her yard, close by their barn which is located on the alley directly across from McCain's, was scarcely fifty feet from where the meteorite struck. She was suddenly startled by a great roar, which she described as being like an airplane going into a power dive. This lasted only an instant and was immediately followed by a sharp cracking sound, as of the breaking of boards. There apparently were no echoes, reverberations, or detonations.

Thinking that it had dropped into the rear of their barn, she at once

rushed out into the alley, expecting to find the roof or the side of the barn crashed in, but seeing no damage she at once looked up into the sky to see if an airplane was in sight. The sky was practically clear at the time, there being no obscuring clouds present, and when she could see no signs of one, she very naturally was greatly perplexed at what had occurred. She said the circumstances of the event kept recurring to her mind all forenoon, but as the day wore on she gradually dismissed it as being "just one of those things."

FIGURE 3

BUILDING SHOWING HOLE IN ROOF MADE BY BENLD METEORITE, THE METEORITE BEING HELD BESIDE THE HOLE BY MR. WILSON.
The arrow is superimposed to show the direction at which the meteorite came to earth.

Mrs. McCain, wife of Ed. McCain, on whose property the meteorite fell, was also in the yard pumping water at the time, and she too heard the sound from a somewhat greater distance, but, being accustomed to hearing and seeing airplanes passing over on their way in and out of St. Louis, thought little of the event, scarcely looking up at all. Being indoors, only a few others residing in the immediate neighborhood reported having heard the sound.

Questioned about the possibility of there being smoke clouds or fumes connected with the fall of the meteorite, Mrs. Crum stated positively that there were none which she could observe. Mrs. Lindy (Chas.) Brown, married daughter of the McCains, residing nearby, being among the first persons to examine the stone after it was discovered, however, said that she could plainly detect the odor of "sulphur" on or about the stone. Concerning the hour of the fall, Mrs. Crum stated positively that it was between 9:00 and 9:10 A.M. No closer verification with a timepiece was made by any who heard it.

The McCain garage, being across the alley from the spot where Mrs. Crum was working at the time, was so oriented that it was not possible for her to see the opposite side of the roof, which was the one actually struck by the meteorite. This accounts for the fact that its discovery was not made until late afternoon. The garage itself was a small oldish, unpainted building, almost square (15 by 16 feet), with a gable portion of roof running lengthwise from east to west, covering a portion (about 10 by 16 feet), of the building, while the remainder of the roof was of "lean-to" construction sloping towards the alley, which the ridge of the gable portion paralleled. It was covered with black "tar-paper" roofing material beneath which there was a layer of good inch pine board sheeting.

FIGURE 4

PICTURE OF PONTIAC COUPE STRUCK BY BENLD METEORITE; CUSHION SHOWING HOLE, AND THE METEORITE BEING HELD BY MRS. ED. MCCAIN, WIFE OF OWNER.

At left is Mrs. Carl Crum, who was working within about fifty feet of spot where meteorite landed, and (right) Principal F. A. Bertetti of the Benld Township High School, who was instrumental in insuring the careful preservation of the stone.

This building was located at the southeast corner of Lot 14, Block 2, of Hoog's Addition to the town of Benld. Consulting the township (Cahokia) map at the Court House in Carlinville[4] the county seat of Macoupin County, we found this to be near the S.E. Corner of S.W. ¼; S.W.¼; Section 31, Township 8 North; Range 6 West of the 3rd Principal Meridian. From data supplied by the U. S. Geological Survey Quadrangle map (Gillespie) of 1912, the latitude and longitude has been calculated as 89° 48′ 52″± West Longitude and 39° 05′ 14″± North Latitude.[5]

In landing the meteorite struck almost the exact center of the north

side of the gable roof, breaking a clean hole, rectangular in shape, about 4x5 inches large, with but little shattering of the sheeting-board. The part which was broken out, however, was reduced to splinters. With its speed apparently only slightly checked, it penetrated the top of the car, a 1928 Pontiac Coupe, (Factory No. 31164628, Eng. No. P349032), which was in good running order, and on which the top covering had been but recently renewed. Here again, it made a clean hole, and passed on down striking the cushion, almost in a dead center of the seat, to the right of the driver. Its momentum again carried it through the cushion, but becoming so entangled in the springs that, after going on through, breaking the floor-board and denting the car's muffler beneath, it was jerked back up into the bottom of the cushion, where it finally found a temporary terrestrial resting place.

Unaware of what had taken place Mr. McCain, on returning from his work at the mine shortly after three o'clock the same afternoon, went to the garage to take his "car out and go up town." Opening the door he immediately saw the large hole in the cushion, and stepping across the alley, he called to his neighbor, Mr. Carl Crum, saying "Come over here Carl, and see what the rats have done to my seat cushion." Entering the garage he continued: "I knew the rats were getting thick around here, but I never supposed they could do that much damage in twenty-four hours."

Mr. Crum opened the car door, and after looking at the seat carefully for a moment said, "Ed, no rats ever made that hole," and at that same moment, straightening up, he saw the hole in the ceiling of the car. The mystery deepened.

Then they backed the car out of the garage and, lifting up the cushion, noted that the board beneath had been broken, and then looking up into the bottom of the cushion they saw a black stony object about as big as "two fists," which they could not remove on account of it being so tangled up in the springs of the cushion.

Thereupon Mr. Crum went back over to his house to "fetch a pair of pliers, with which to cut the wires," and while there told his wife what had happened to the McCain car. She at once associated the matter with her experience of the forenoon, and going back to the garage observed the hole in the roof. Thus matters began to straighten themselves out. Something had actually fallen out of the sky, and, "that did make sense." On removing the stone from the cushion they immediately realized that it was of meteoric origin, and that the occurrence was most extraordinary.

Soon the word spread around and the neighbors began to gather and to relate their experiences, and to make their own speculations and draw their own conclusions. "Yes, it must have been a meteorite, for what else could it be." "A good thing I wasn't sitting there in my seat when it landed," said Mrs. McCain, when she realized what had actually happened, and all present agreed with her laughingly. The cushion was

carefully preserved and is now in Joliet.

That evening the meteorite was taken up town and exhibited at various stores and offices, and a small fragment was broken off one corner with pliers, "by a Doctor, to find out what it was made of." Fortunately, this enabled us to examine a freshly broken surface which revealed a stone of granular chrondrulic texture, of a dark grey color, throughout which were scattered numerous specks of bright silvery metallic luster. Some also appeared to be of bronze-like lustre. A complete report on the mineralogical content of the meteorite will be made later. One other much smaller fragment about the size of one's finger nail had been broken off, apparently in striking the building when falling. This could not be found. How the stone ever came through the garage and stopped without being broken into many fragments seems strange when one considers the full force of the impact.

FIGURE 5

VIEW SHOWING PRISMATIC ASPECT OF BENLD METEORITE. ALSO SMALL CORNER REMOVED FOR ANALYTICAL DETERMINATION.

The entire stone was covered with a jet black velvety crust, so characteristic of such meteorites, which appeared at the broken surfaces to be from ½ to 1 mm in thickness. On three sides were exhibited numerous beautiful and highly characteristic "thumb markings," or piezoglyphs, showingnig well-defined flow lines. On the other sides these features were less developed. On one blackish triangular surface, the crust seemed to have been worked up almost into a froth, which when greatly magnified appeared to be quite blistery, showing plainly a ripple-like sloughing exhibiting definite wind pressure patterns indicative of direc-

tional influence.

The stone could be said to be roughly rectangular in shape, slightly more oblong than square, as will be noted by the dimensions, which were approximately 110x90x80 millimeters (4⅜x3½x3¼ inches). The almost prismatic features of its outline gives it a very striking appearance and it is indeed a handsome specimen. The weight of the meteorite was obtained carefully in grams upon the standard specific gravity balances employed in physics laboratories, and was found to be 1770.5 grams in air, which is some 40 grams less than four pounds. Considering the small fragments which were removed, the weight of which could

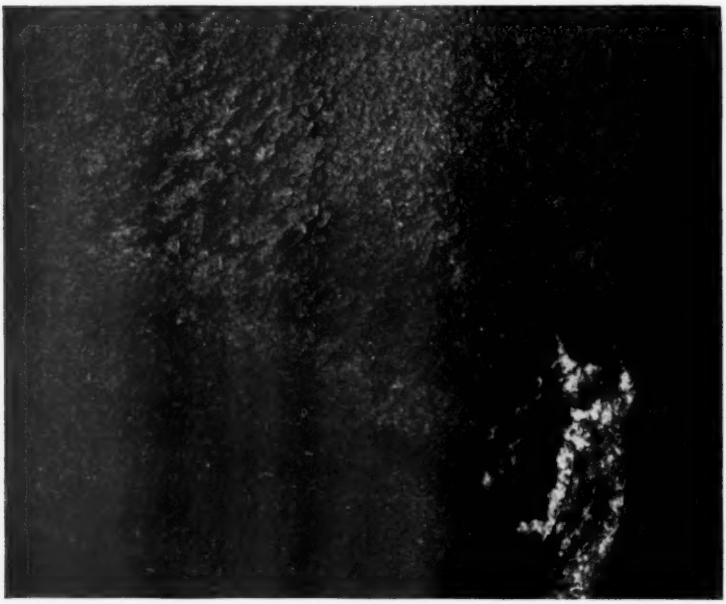

FIGURE 6

MAGNIFICATION SHOWING DETAILED CHARACTER OF CRUST, RESEMBLING BLISTERING. FLOW LINES ARE ALSO WELL DEVELOPED.

not be accurately ascertained, I would say that Mr. McCain's statement first made in his letter, as to weighing four pounds, was for all practical purposes correct.

When immersed in water for obtaining its specific gravity, it was noted to be slightly porous, for tiny streams of bubbles emerged from the surface at various well-defined points, which presumably were of air, but might have been of some other occluded gas which was unidentified. Its weight in water was found to be 1291.5 grams when first weighed

and 1293.5 grams for the second weighing, which showed an absorption of about 2 cc of water. This gave us a specific gravity of 3.69, which is near the average for meteorites of the stony-iron type.

Our final problem was to determine the exact angular direction at which the meteorite came through the building and car. This was done with a regular surveyor's transit, having an attached vertical vernier. We first saw that the car stood in the exact location as at the time of the fall—which was a comparatively easy matter as the car had worn a well-defined rut in the dirt floor of the garage, with a good sized depression where the wheels came to rest. The car would ordinarily stop in no other position. We next fixed the center of the hole on the roof with nails and cross strings, and fastening a string at the center we dropped it down through the hole in the top of the car, and extended it through the center of the hole in the cushion to the ground. This was possible, due to the fact that part of the broken floor board had been removed. When properly centered these holes were found to be in perfect alignment, which was further proof that the car was standing in the same location as when struck. We next fastened the lower end of the string firmly to the ground by means of a nail, and then severed it and drew it up through the top of the car. The car was then backed out of the garage and the line of the string was re-established by means of the nail in the ground. With a plumb-bob suspended from the ceiling a definite point on the line of the string was determined and fixed, and the string was once more removed.

The transit was next set up and the axis of the barrel of the telescope was carefully lined in with this point fixed with the plumb-bob. The plates were leveled and oriented with magnetic north, and the clamps were then released and the cross hairs of the telescope were made to coincide with the crossed strings at the center of the hole made by the meteorite in the roof. In this manner the bearings were obtained.

It was found that the course at which the meteorite came through the building was 60° 01′ East of magnetic north, adding 4° 45′ for correction,[5] gave us a bearing of 64° 46′ East of true North, for the direction from whence it came. The vertical elevation was 77° 31′ from the horizontal, or 12° 29′ from the vertical, which if projected directly into the heavens, and corrected for date, hour, and latitude would strike a point slightly outside and below the β star of Ursa Major (Big Dipper). This fact, however, is of little value, as meteorites are known to drop rapidly while passing through the earth's atmosphere, as they approach the earth, and therefore the calculation of the real radiant and velocity is dependent upon our luck in obtaining direct bearings upon its distant course by observers residing from 50 to 200 miles from the point of the fall. This we will attempt to do through the coöperation of schools and newspapers located in the direction from which the meteorite came.[6]

Two other problems concerning the meteorite present themselves to us at this moment. One is the question of whether or not the velocity

might be determined by calculating the momentum. In other words, how fast would a four-pound object of a given size and shape have to travel, or how much work would have to be done, to penetrate the roof of the garage and the cushion, floor board, etc., of the car, as in this instance. The second matter which suggests itself is the nice little problem as to the amount of deflection in the course of the meteorite which would be caused by its passing through a plain roof, oriented east and west, and sloping at about 30° from the horizontal, and then falling in the direction and angle previously ascertained.

Only superficial search was made at the time for additional stones, and while none were found, it is by no means certain that others may not turn up later. From the appearance of the stone recovered, however, it could be stated rather positively that it had not been fractured into other pieces while passing through the atmosphere, as the fused coating appeared so complete and uniform throughout as to preclude this possibility. It may have been a lone wanderer, unaccompanied by any other celestial object. One cannot help remarking how fortunate that it did actually strike the building squarely, for had it hit and buried itself in the weed-covered ground only a few feet away, in all probability it would never have been recovered.

In closing we must also give much credit to Principal F. A. Bertetti and Mr. Archie Toigo of the science department of the Benld Township High School for their friendly coöperation throughout our investigation, and for their ability in recognizing the true character and value of meteorites, thus insuring its safe preservation for the use of future investigators.

Ben Hur Wilson, *Investigator.*
Frank M. Preucil, Jr., *Photographer.*

Footnotes

[1] A report given by Ben Hur Wilson, before the members of the Joliet Astronomical Society, on the occasion of the Premier Announcement of *The Benld Meteorite* (Illinois No. 2). Preliminary reports had been given at prior regular meetings on October 11 and 25. At the same meeting Mr. Frank M. Preucil, Jr., showed about twenty-five slides illustrating all phases of the fall, six selected pictures of which are published with this report. Mr. Preucil also lectured on various technical aspects as revealed by the photographs.

[2] The Tilden Meteor, by C. C. Wylie. Popular Astronomy, Vol. xxxv, No. 8. (Oct. 1927), pp. 453-4.

[3] *Benld,* a mining town in southern Illinois, named after Ben L. Dorsey, a prominent land owner in that vicinity.

[4] Consulted maps on file in the office of County Engineer of Macoupin County, at Carlinville, Illinois.

[5] Computed from U. S. Quadrangle Map (Gillespie), published in 1912.

[6] This investigation and research is now being conducted by Dr. C. C. Wylie, President of the Midwest Meteor Association, Iowa City, Iowa.

Astronomy in the Early Days of the Western Reserve

By R. H. CLEMINSHAW

On the night of November 13, 1833, Elias Loomis, a twenty-two year old Latin tutor at Yale College, watched the skies fairly rain meteors. It was the famous Leonid shower of 1833 in which it has been estimated that between midnight and dawn more than two hundred thousand meteors could have been seen from one place. This magnificent display might also well be considered the beginning of astronomy in the Western Reserve. Before this time Loomis had shown more of a love for languages than for science, but now we find him discussing with Professor Olmsted of Yale the character and origin of these interesting and mysterious meteors.

By 1834 Loomis was definitely launched on a scientific career. He had turned to the tutoring of mathematics and was serving on the Committee on Mathematics and Natural Philosophy of The Connecticut Academy of Arts and Sciences. From November, 1834, to November, 1835, he found time each day to make seventeen hourly observations of the variation in the declination of a compass needle which he had carefully and accurately mounted near the north window of his room. These observations and a discussion of the extraordinary cases of disturbances in declination were published in the *American Journal of Science* in 1836 and constituted the first record of such magnitude and thoroughness published in the United States.

In 1835 Loomis became a tutor in Natural Philosophy. During the previous year he and Professor Olmsted had continued their researches on shooting stars and had published the results in the April, 1835, number of the *American Journal of Science*. They reached the conclusion that the apparent motion of shooting stars was a result of a combination of the rotation of the earth and the motion of the meteors in reference to the earth's atmosphere. They computed the latter motion to be between 18 and 36 miles per second.

In 1830, while Loomis was a senior at Yale, the college received a 5-inch telescope as a gift from Mr. Sheldon Clarke. Although this instrument was at that time larger than any other telescope in the country, no provision was made by the college for the proper mounting of it. The telescope was therefore mounted on casters and taken up to a room in the tower of the Atheneum, one of the college buildings. When observations were to be made, it was wheeled to one of the windows in this tower; if no window happened to be located where the desired observation was to be made, there was nothing for the astronomer to do but wait until the stars had apparently moved to a position that would fit in with the architecture of the tower. This temporary arrangement continued

for over thirty years. In spite of such a handicap, Loomis and Professor Olmsted were the first in the United States to observe the return of Halley's comet on August 31, 1835, and were able to make enough observations to compute its orbit. Loomis also made sufficient observations of Polaris and of the moon to compute the latitude and longitude of the tower. His computed longitude differs from the best determination of today by less than two seconds of time.

At the time Loomis was entering Yale, three freshmen were registering as the first students in a newly formed college located in Hudson, Ohio. Hudson was chosen as the site for this institution possibly because of its high and healthful location but more probably because the town had subscribed $7,500 toward the founding of the college. Of this amount David Hudson, the founder of the town, had subscribed $2,142 and had donated 160 acres of land. At the time these three freshmen registered, the first college building was not completed so the young men were sent to the nearby village of Tallmadge to study under Mr. David L. Coe, a graduate of Williams College. Such was the beginning of the first college west of the Alleghenies. It was very fittingly named Western Reserve College.

It soon became apparent that, in addition to offering courses at the college level, the new institution would have to provide a preparatory department as well. Although this department was first considered a temporary expedient, the need for it continued to exist and in 1839 the department was made a permanent part of the college. When Western Reserve College was moved to Cleveland in 1882, this preparatory department remained in Hudson as the Western Reserve Academy and as such continued to receive financial assistance from the college until 1900.

It was to the chair of Mathematics and Natural Philosophy in this new Western Reserve College that Loomis was elected at a meeting of the board of trustees held on April 14, 1836. At this meeting the trustees appropriated the sum of $4,000 for the purchase of "philosophical and astronomical apparatus" and authorized Loomis to spend a year in Europe during which time he was to purchase such books and apparatus as would come under the above heading. The sum of $4,000 seems to have been the standard for equipping an observatory in those days, for this is the exact sum appropriated by Williams College for its observatory which was to be completed a few months before the one at Western Reserve. Loomis sailed from the United States in July, 1836, and returned to Hudson on September 20, 1837.

In a little building in the rear of North Hall on the campus of Western Reserve College was housed a printing plant, one of the college "work shops" in which the students were supposed to get the exercise they now get in the gymnasium and on the athletic field. One of the products of this printing plant was the *Ohio Observer,* a weekly newspaper chiefly devoted to articles on controversial texts in the Bible and to editorials on the wickedness of strong drink and of travelling on the

Sabbath Day. Before leaving for Europe, Loomis agreed to send an account of his trip for publication in the *Ohio Observer*. His thirty-six letters from Europe give a good account of his travels through the British Isles and France but fail to mention how and where he accomplished the purchase of the "philosophical and astronomical apparatus" which he had been commissioned to buy.

From the observatory on Carlton Hill in Edinburgh he wrote, "How ludicrous it seems that we should be reckoning the longitude of other cities from Washington when we have not the means of determining the longitude of our own capital!" At Slough, England, he viewed the unique telescope used by Sir Wm. Herschel and at Cambridge he carefully examined the university observatory which he described as one of the best in Europe. But Paris seemed to have received his most thorough attention, for eighteen of his thirty-six letters were devoted to the description of this delightful city, its inhabitants and its institutions. One whole letter was devoted to the Paris Observatory in which no wood or iron was used in the construction and which was presided over by three generations of Cassinis who ruled as astronomical dictators until thrown out by the gentle revolutionists of 1790.

Loomis evinced almost a fanatic zeal for discovering new scientific truths or for verifying facts which had been discovered by others. Just a month after his return to Hudson, an event occurred which must have more than spurred the interest which he had already evinced in meteorology. The little town of Stow, less than ten miles south of Hudson was visited by a hurricane which destroyed many of the log houses and entirely wiped out one family. Loomis immediately went to the scene of the hurricane and made a careful note of the direction in which all trees had fallen and particularly noted the trajectory of an ox cart which was blown a distance of 30 rods and high enough in its flight through the air to entirely clear the roof of a barn. "The stoutest oaks of two feet diameter were snapped like walking canes." "It is desirable that the leading features of every great hurricane should be faithfully recorded that we may in time be enabled to decide into how many classes they are to be divided." (*American Journal of Science*, January, 1838.)

The observations made at Stow gave Loomis enough information to form at least an hypothesis as to the nature of storms. He followed the course of what is now defined as the "scientific method" by immediately searching for more facts with which to test his hypothesis. Nature had very obligingly provided a storm which raged throughout the United States on December 20, 1836, a date so near the winter solstice as to give Loomis an opportunity to follow up a suggestion made by Sir John Herschel who had recommended that hourly meteorological observations be made for thirty-six hours at each solstice and each equinox of every year. Loomis therefore sent out inquiries to all parts of the United States and Canada where meteorological observations were being taken asking that they send him all their data for the days just previous to and

just after December 20 as well as the data for that day. From the information received he was able to present a report which he read to the American Philosophical Society in 1840. This report contained maps on which he had traced the path of the lines of lowest barometric pressure from hour to hour during the course of the storm. He was later to improve on this method of indicating storm movements, but this advancement was considered of such scientific importance that several other leading meteorologists immediately adopted Loomis's method and in some cases adhered to it for many years.

Life in Hudson must have been a busy one for the new Professor of Mathematics and Natural Philosophy. The Leonid shower of 1833 still continued to intrigue the young scientist, for in the November 23, 1837, number of the *Ohio Observer* we find him writing of an all-night vigil which he kept with twelve of his college students on the night of November 13, 1837. The twelve students were divided into three groups, each group watching the sky for two hours at a time. Although the night was rather cloudy, Loomis and his crew obtained a count of 27 meteors per hour. His comment was that "the exhibition of meteors this morning was in no respect extraordinary."

There was also the question of selecting a site for the new observatory. This seems to have been settled at a meeting of the trustees held November 30, 1837, when it was determined that the observatory should be built on the southwest section of the college campus. When one views the observatory today nearly surrounded by beautiful and stately elm trees, it is hard to picture the conditions in 1838 when Loomis wrote that "the transit commands an unobstructed vision from 90° zenith distance on the south to 89° on the north."

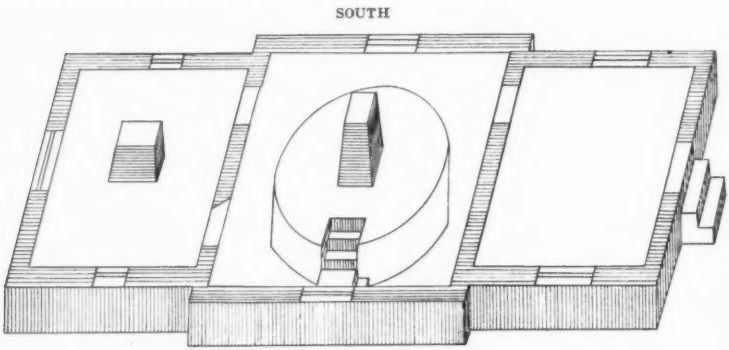

FIGURE 1

PLAN VIEW OF THE LOOMIS OBSERVATORY

The plan of the observatory is shown in the accompanying figure. In the center room was the equatorial telescope made by Simms of London. This instrument was mounted on a stone pier and was reached by steps

leading up to a four foot platform which just afforded room for Loomis to move his chair around without bumping into the twelve cherry columns which helped sustain the nine foot dome. The telescope had a focal length of 66 inches with an object glass of 3.8 inches clear aperture. It had six celestial eyepieces with magnifying powers from 20 to 400; a terrestrial eyepiece; and an eyepiece with five parallel spider lines crossed by as many others at right angles.

The transit was mounted on a stone pier in the room to the east of the central room. In the northwest corner of the transit room was hung a sidereal clock made by Molineux in London. Loomis provided an opening in the side wall between the transit and equatorial rooms so that the clock could be seen from the platform in the equatorial room. This clock is now housed in the Physics Laboratory of Western Reserve University and is still keeping excellent time after one hundred years of operation.

The west room of the observatory was equipped with a table and a wood stove. Here in this nine by ten room Loomis worked at such times as he could spare from teaching classes, inspecting boys' rooms and leading at the prayers with which every faculty meeting was opened. The entire observatory was only 16x37 feet and the cost of construction was $1,087.57.

Loomis's own account tells the story of his progress: "The instruments were first placed in the observatory on September 8, 1838, and I at once applied myself diligently to their adjustment . . . I pursued a systematic course of observations as far as my engagements in the college would permit and without the advantage of an assistant. Among these observations may be mentioned 262 moon culminations for longitude, 69 culminations of Polaris for latitude, 16 occultations, 5 comets with sufficient accuracy to determine their orbits, besides a great variety of other objects, for regulating the clock, etc."

But the fact that he now had an observatory did not mean that Loomis had lost interest in meteorology. He continued to make daily weather observations which were published each month in the *Ohio Observer*. He made quite a study of the number of clear days in Hudson compared to the number in Hanover, New Hampshire, and concluded that Hanover was between two and three times as good as Hudson in this respect. His comment will probably be appreciated by those astronomers who have had to carry out a program in the Great Lakes Region: "To the astronomer these are perhaps the most important meteorological observations, as they indicate the most suitable site for an observatory. At Hudson, for example, during four months of the year astronomical observations are almost entirely impracticable."

In Loomis's time the college year ended with commencement in the middle of August followed by a two months holiday before the opening of college in the middle of October. In 1839 Loomis devoted his entire vacation to making a study of the magnetic inclination in twenty-two

different towns and cities in the eastern part of the United States. It took him nearly two weeks to make the trip from Hudson to Buffalo, the end of the railroad at that time. From that point on, however, he made practically as good time as any troop of actors hardened to one night stands. The procedure in each town was the same. Loomis would set up his dipping needle at some point far removed from any iron and would then proceed to take 160 readings.

On February 4, 1842, a tornado passed some fifteen miles north of Hudson. Professor Loomis and Samuel St. John, the newly elected Professor of Chemistry, immediately set off to examine the path of the storm. They noticed that clapboards had been driven deeply into the earth and conceived the idea of computing the wind velocity by shooting like clapboards out of a gun and noting how deep these clapboards were driven into the earth. Somewhere their experiment seems to have gone astray, for they arrived at a wind velocity of 682 miles per hour. However, this storm again started Loomis on the trail of more meteorological data. When these data had been collected, Loomis used them to plot lines of equal barometric pressure on his weather maps, which maps were perhaps the forerunners of the maps now published daily by the United States Weather Bureau. In his 1842 report Loomis urged that the government institute a central weather bureau which would collect data and publish weather maps. Fortunately Loomis was a long-lived individual and therefore did not die before his idea was finally adopted. It was a wait of twenty-nine years, though, before the United States Signal Service was finally established and began the publishing of daily weather maps. Loomis lived eighteen years longer and was able to study the data furnished by the Signal Service. The result of this study as published in the *American Journal* was one of the great contributions to our knowledge of meteorology. Nine of the papers were translated into French.

During the year 1843 the young college seemed to have great difficulty in paying its professors. The minutes of the trustees have several references to Professor Loomis' "pecuniary embarrassments." The only satisfaction the trustees could give Loomis was to refer the matter to a "committee of finance." This committee apparently was unable to find much real money, for in August, 1844, Loomis resigned to accept a professorship at New York University. His successor, Professor James Nooney, apparently used the observatory only for routine time observations. Nooney resigned in 1848 and the chair of mathematics and natural philosophy remained vacant until Charles A. Young was elected in 1856. During the nine years Professor Young was on the campus the observatory was once more in continuous use and must have contributed to the knowledge which Professor Young was later to pass on to other generations at Dartmouth and Princeton.

Long before Loomis died, the spark of interest in astronomy which he had kindled in the Western Reserve had spread to other places west

of the Alleghenies. Today, the little observatory which he built stands as a living monument to the scientific spirit of the man who first labored in it. His contributions to science were many and his vigor and lively enthusiasm furnish an inspiring example for the young men who now study the stars in Hudson.

The Eclipse of 1938 November 22— A Partial Solar Eclipse Visible in the Tropics

By ALEXANDER POGO

Taking the earth as a whole, there are, on the average, in one hundred consecutive years, 84 partial solar eclipses. About 4 out of 9 partial solar eclipses are visible in the tropics. A partial eclipse of the sun is visible in the tropics, on the average, once in three years, although it is not unusual to have two partial solar eclipses visible in the tropics within six months, and it is even possible to have three partial solar eclipses visible in the tropics within eleven months.

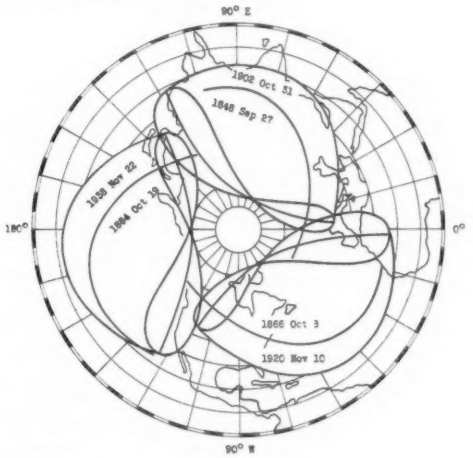

FIGURE 1
PARTIAL ECLIPSES NOS. 5 TO 10 OF SAROS SERIES S49.

Table I shows the 39 partial solar eclipses visible in the tropics between 1834 and 1942. The partial eclipses of 1834 January 9—immediately preceding the first eclipse of the table—and of 1942 March 16, belonging to the solar saros series S90, may be considered as the limits of the interval of six saroses covered by Table I; of the 88 partial solar eclipses of this interval of 108 years, at least 39 must be classified as

eclipses visible in the tropics. Table I does not list the partial eclipses of 1866 October 8 (saros series S49) and of 1873 November 20 (saros series S137); the curves of simple contact of these two eclipses passed within a few minutes of arc north of the Tropic of Cancer and south of the Tropic of Capricorn, respectively.

Partial solar eclipses visible in the tropics occur in every solar saros series, both before and after the umbral run of the series. The diagram reproduced in Figure 1 shows the terrestrial areas swept by the moon's penumbra during the eclipses of 1902 October 31, 1920 November 10, and 1938 November 22, belonging to the initial penumbral run of the solar saros series S49; the curves of simple contact of the eclipses of the previous exeligmos are indicated on the diagram; these curves illustrate the fact that the eclipse of 1884 October 19 was the first eclipse of the saros series S49 visible in the tropics. Four tropical eclipses approach-

TABLE I

PARTIAL SOLAR ECLIPSES VISIBLE IN THE TROPICS

S95	1834 Jne 7	1852 Jne 17	1870 Jne 28	1888 Jul 9	.....	.....
S131	1837 May 4	1855 May 16	1873 May 26	.....	.....	.....
S137	1837 Oct 29	1855 Nov 9	.....	.....	.....	.....
S148	.....	.....	.....	1892 Oct 20	1910 Nov 2	1928 Nov 12
S178	.....	.....	.....	1895 Mar 26	1913 Apr 6	1931 Apr 18
S183	1841 Jul 18	.....	.....	.....	.....	.....
S184	.....	1859 Aug 28	1877 Sep 7	1895 Sep 18	1913 Sep 30	1931 Oct 11
S219	1844 Jne 16	1862 Jne 27	.....	.....	.....	.....
S2	1844 Dec 9	1862 Dec 21	1880 Dec 31	1899 Jan 11	1917 Jan 23	1935 Feb 3
S7	.....	1863 May 17	.....	.....	.....	.....
S43	.....	1866 Apr 15	1884 Apr 25	1902 May 7	1920 May 18	.....
S49	.....	.....	1884 Oct 19	1902 Oct 31	1920 Nov 10	1938 Nov 22
S90	.....	.....	.....	.....	.....	1942 Mar 16

ing the equator and belonging to the initial penumbral run of the solar saros series S2 were mapped in the diagram reproduced in Figure 1 of a previous paper (POPULAR ASTRONOMY, **43**, 96, 1935); three tropical eclipses receding from the equator and belonging to the terminal penumbral run of the solar saros series S148 were shown on the diagram reproduced in Figure 3 of the same paper (*ibid.*, p. 97).

In the case of the solar saros series S43, the initial penumbral run began in September, 1541, ended in May, 1920, and consisted of 22 eclipses; on account of the slow changes characterizing the "hibernation" of the winter eclipses of a saros series, it took the eclipses of this penumbral run three centuries to reach the Tropic of Capricorn; the advance through the tropics was, on the contrary, rather rapid—it was accomplished by the four spring eclipses of 1866, 1884, 1902, and 1920.

In the case of the solar saros series S49, the initial penumbral run, be-

ginning in August, 1776, and ending in February, 2083, will consist of 18 eclipses; the first third of this penumbral run brought the eclipse of 1866 within reach of the Tropic of Cancer; the autumn eclipses of 1884, 1902, and 1920 followed the corresponding spring eclipses of the saros series S43 at intervals of six months; the winter eclipses, characterized by slow changes, will carry the initial penumbral run of the saros series S49 through the XXIst century; the initial penumbral run of S49 will thus have a dozen partial eclipses visible in the tropics.

An interesting case is presented by the tropical eclipse of 1863 May 17, belonging to the terminal penumbral run of the solar saros series S7. This first eclipse of the terminal penumbral run was the only eclipse of the run visible in the tropics; the eclipse of 1881 May 27 swept the polar and temperate zones only; the summer eclipses of this terminal run will bring it to a close in July, 1971.

Another interesting case is presented by the initial penumbral run of the solar saros series S137—a case of a "premature invasion" of the tropics. The run started in August, 1729, and rapidly reached the neighborhood of the Tropic of Capricorn; the eclipses of 1837 and 1855 were actually visible within the tropics, the northern limit of simple contact reaching the latitude 22°S; the subsequent eclipses of this initial run remained, however, invisible in the tropics; a second crossing of the Tropic of Capricorn will follow; there will be 22 partial eclipses in this initial run, but less than half of them will be visible in the tropics.

CARNEGIE INSTITUTION
WASHINGTON, D. C.
1938 OCTOBER 31

Revised Orrery Calculations

By CHARLES E. BALLEISEN

ABSTRACT

In a recent paper, "Two Inexpensive Orreries," calculations were given for the gear trains required to construct an orrery showing the system Sun-Mercury-Venus-Earth-Mars and an orrery showing the system Sun-Earth-Moon, both the rotation of the Moon about the Earth and the regression of the Moon's nodes being portrayed.

The present paper shows how the first mentioned orrery can be greatly improved by slight changes in the gear ratios. In the case of the second orrery, a vital error in the motions of the Moon's geocentric revolution and in the regression of the Moon's nodes is disclosed. By the calculations of the original paper, the Moon's nodes rotate about the line of syzygies in 18 years instead of in 50 weeks. The error in the geocentric revolution of the Moon causes 13⅓ synodic periods to be performed each year instead of 12⅓. This paper presents calculations for the orrery in which these errors have been eliminated and the period of the diurnal rotation of the Earth improved.

In a recent paper, "Two Inexpensive Orreries," by Dr. Roy K. Marshall, descriptions were given of the gear trains required to reproduce the motions of certain elements of the solar system. In the first

orrery, the system Sun-Mercury-Venus-Earth-Mars was displayed, and in the second, the system Sun-Earth-Moon, involving both the geocentric revolution of the Moon and the regression of the Moon's nodes.

Noting that only simple gearing had been employed in the first system, trial calculations were made using compound gearing, and the errors were so greatly reduced that it was decided to entirely recalculate this orrery using the general plan proposed by Dr. Marshall. The results of this work are given in Part I below.

By checking the calculations for the second of these orreries, it was found that serious errors had been made in determining the ratios to be used for displaying the geocentric revolution of the Moon and the regression of the Moon's nodes. As this latter mistake was so gross as to entirely prevent the machine from exhibiting the lunar phenomena even approximately, this orrery, too, was entirely recalculated, using the original plan as a basis. The details of this work, pointing out the errors of the original paper and giving the gearing required for a more nearly accurate representation are contained in Part II.

Part I

Sun-Mercury-Venus-Earth-Mars Orrery

The original paper admitted that the gear trains proposed did not exactly represent the planetary motions. However, the errors were given as the number of degrees by which the orrery planet differed from its true position after one sidereal revolution of the Earth. If all the planets moved at the same rate, this method of showing errors would be satis-

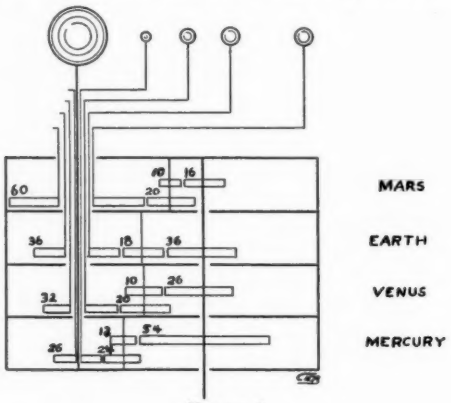

Figure 1

	Absolute Error	Relative Error
Mercury	—5°27	—0.35%
Venus	—3.90	—0.67
Earth	0.0	0.0
Mars	+2.88	+1.50

factory, but as they do not, it would be more nearly exact to present the errors as a fraction of the total arc traversed by the true planet during a given time.

The table below shows the absolute errors after the passage of one earthly year and the same errors when reduced to a percentage of the annual travel of the planet.

By the use of compound gearing, these errors can be greatly reduced, and also the number of shafts required and the list price of the gears themselves can be lowered. Gearing which has been determined to do this is listed in the following table and also shown schematically in Figure 1.

Mercury	Venus	Earth	Mars
54	26	36	16
12-24	10-20	18	10-20
26	32	36	60

It may be noticed that the replacement of the 84-44 gear train of the original Mars unit has permitted a closer center-line distance and that the extra idler gear in each of the other trains, which was formerly required in order that all the planets would revolve in the same direction, has been removed.

The errors produced by these gear trains, as well as the arcs traversed by the planets, both true and orrery, during one earthly year are shown by the following table:

	True Arc	Orrery Arc	Error Absolute	Error Relative
Mercury	1494°76	1495°38	+0°62	+0.041%
Venus	585.189	585.000	—0.189	—0.032
Earth	360.00	360.00	0.0	0.0
Mars	191.406	192.000	+0.594	+0.31

The relative errors shown in the above table are greater than ⅕ of the errors given in the original paper in only one instance (Mars). The number of gears required in the original paper was 14, by this method 15, but the list price of the 14 original gears was $4.03, while that of these 15 gears is $3.58, a reduction of $0.45. In addition, the number of shafts required has been reduced from 11 to 9, which means a reduction in the work of preparing the shafts, bearings, etc. As the maximum center line distance between the driving and driven shafts has been reduced, there will also be a lowered cost in the material required for the framework, spacing plates, and mountings.

Part II

Sun-Earth-Moon Orrery

This orrery is complicated by the fact that the gears are contained in an arm which rotates about the Sun in a period of one year. If the Sun shaft is considered stationary, then the problem is one of reproducing the sidereal motions with a system of epicyclic gearings. The system may also be handled by assuming the arm (line of syzygies) to remain

stationary, and the Sun shaft to rotate in a retrograde direction with a period of one year. The problem is then reduced to the computation of synodic periods with common gearing. The latter method has been used in the following work.

First to be considered is the gear train producing the annual rotation of the earth's axis with respect to the line of syzygies. In this calculation, as in the original, this motion is produced by two sets of 18-18 bevel gears so that there is a one to one ratio between the rotation of the Sun shaft and the Earth's axis. The motion of the Earth's axis, however, is retrograde, or clockwise when observed from the north. This one retrograde revolution per year, when added to the one direct revolution of the arm per year, causes the Earth's axis to remain stationary in space, which is as is required.

The Earth rotates upon its axis with respect to the line of syzygies 365.256 times per year (solar days). As the Earth globe in the orrery is carried upon an arm which makes one retrograde revolution per year, the gears must provide a ratio of 366.256 rotations of the Earth to one of the Sun. This agrees with the original paper. The gear trains used produce a ratio of 366.300, or a relative error of +0.012%.

The synodic period of the Moon is 29.531 days, which is equivalent to 12.3686 synodic months per year, or 13.3686 sidereal months per year. If, as is done in the original paper, the gearing produces 13.3686 revolutions of the Moon to one of the Sun, the representation will be incorrect. Recalling that all motions are to be computed with respect to the line of syzygies, it is apparent that the rate to be reproduced is the synodic one. Hence, the gearing should revolve the Moon about the line of syzygies 12.3686 times per year. The gearing used gives a ratio of 12.3429, or a relative error of —0.208%.

The largest mistake in the original paper was in the development of the calculations for the regression of the Moon's nodes. By neglecting the difference between the sidereal and the synodic periods of this motion, such a large error was introduced that in the orrery presented in the original paper, the nodes would each pass through the line of syzygies every 18 years. To anyone who is familiar with eclipses, it is readily apparent that the nodes pass every 50 weeks, and that therefore eclipses can occur every six months, while in the orrery described by Dr. Marshall, they would occur in groups every 9 years.

In developing the theory of this motion from the beginning, it is first found that the sidereal month consists of 27.3217 days, while the nodical month consists of 27.2122 days. Hence, the arc through which the nodes pass during a nodical month is

$$\frac{(27.3217 - 27.2122)}{27.3217}$$

of a complete circle, or

$$\frac{(27.3217 - 27.2122)\ 360.00}{27.3217}$$

degrees, and as this is repeated every nodical month, or 27.2122 days, the total arc through which the nodes will regress in one year is

$$\frac{(27.3217 - 27.2122)\ 360.00 \times 365.256}{27.3217 \times 27.2122} = 19°.36.$$

This arc of 19°.36 is retrograde with respect to the equinoxes. In the same time (one year) the line of syzygies makes one complete direct rotation with respect to the equinoxes, or, what is the same thing, the equinoxes make one complete retrograde rotation with respect to the line of syzygies. As a result, the nodes move 379°.36 retrograde with respect to the line of syzygies each year. It is therefore necessary to design the orrery to produce a motion of 379°.36 of the nodes for every 360°.00 rotation of the Sun. The ratio of 379.36 to 360.00 is 1.05377. The gears proposed produce a ratio of 1.05230, giving an error of —0.140%.

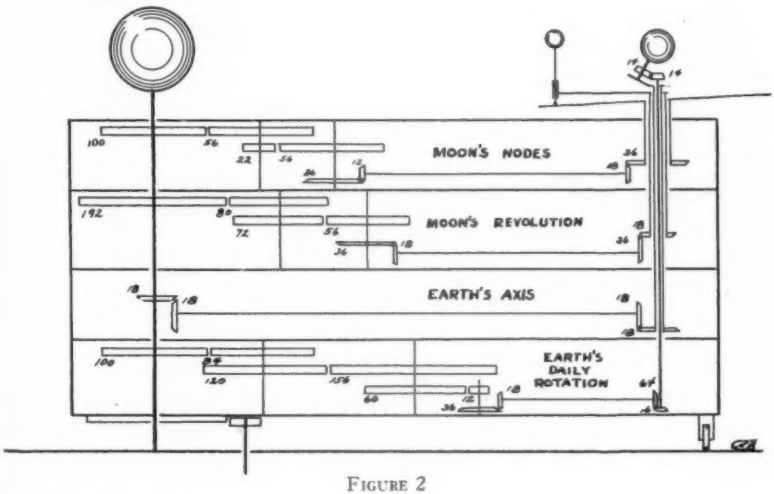

FIGURE 2

The complete system is outlined in Figure 2, and the gears are tabulated in the table below.

Earth's Daily Rotation	Earth's Annual Rotation	Moon's Revolution	Regression of Lunar Nodes
100	18	192	100
84-120	18-18	80-72	56-22
156- 60	18	56-36	56-36
12- 36		18-36	12-18
18- 64		18	36
16- 14*			
14*			

The last two gears in the train for the Earth's daily rotation (those marked with an asterisk) are set at an angle of 23° instead of on parallel

shafts, and it will probably be necessary to do considerable work on them with a file before they will fit smoothly at this angle. It is believed better to use these two spur gears rather than to use one bevel and one spur gear, as was originally proposed.

All the 32 gears listed above are listed in the catalogues of either the Boston Gear Works, Inc., or the Atlantic Gear Works, and are 48-pitch ⅛-inch face gears which are kept in stock by these organizations. Their total list price is $16.85.

The true and orrery ratios and errors are given in the following table:

	True Ratio	Orrery Ratio	Error %
Earth's axis	1.000	1.000	0.0
Earth's daily rotation	366.256	366.300	+0.012
Lunar revolution	12.3686	12.3429	—0.208
Lunar nodes	1.05377	1.05230	—0.140

It is believed that these ratios will be found sufficiently accurate for general use, and, while it is possible that the errors may be reduced by the use of other gears, it seems likely that an appreciable reduction can be obtained only when special gears are employed.

ABERDEEN, MARYLAND, AUGUST 29, 1938.

NOTE: Dr. Gingrich was kind enough to let me see Mr. Balleisen's manuscript before publication. I can say only that I am amazed that anyone should have read my paper so thoroughly as to find the errors, dismayed that such blunders should have been made, but gratified that they have been detected and that there are others interested in such pieces of apparatus. Dr. William Calder of Knox College has pointed out to me in conversation that, for anyone not especially experienced in small machine work, larger gears—say, 32 pitch—might be used instead of the smaller ones first suggested. This may, however, involve some change in the degree of accuracy attained by Mr. Balleisen.

September 18, 1938. ROY K. MARSHALL.

Occultation of Uranus during the Total Eclipse of the Moon, November 7-8, 1938

By THOMAS D. BARRY, S. J.

The total eclipse of the moon on November 7-8, 1938, was heralded as having this peculiarity that both the sun and the moon would be above the horizon at the beginning of the eclipse, due to the fact that, although the sun would be actually below the horizon, atmospheric refraction would make it appear above. But a still rarer phenomenon, the occultation of a major planet during a total eclipse, seems to have escaped the notice of all the predicters, including the *American Ephemeris* and the *Nautical Almanac*.

The eclipse was observed here at Weston College (about 15 miles west of Boston) by Father James K. Connolly, S.J., with a 5-inch refractor and by myself with a 3-inch. A bank of clouds along the eastern

horizon hid the moon until about 5:00 P.M., E.S.T., so the moon was already in eclipse when we first saw it. The western half of the moon was much darker than the eastern half. Our main purpose in watching the eclipse was to observe the occultation of BD +15°414 (mag. 6.9). When we located the star in our telescopes we were surprised to see another, brighter object to the north of it and also in line with the advancing moon. The occultation of the star was observed by Fr. Connolly at $5^h\ 42^m\ 31^s.2$ and by myself $0^s.4$ later. The other object, disappearing gradually, was observed by both of us at $5^h\ 50^m\ 36^s.4$. The reappearance of +15°414 was observed by Fr. Connolly at $6^h\ 38^m\ 46^s.6$. Subsequent investigation showed the extra occultation to be that of Uranus, which had not been predicted. Both the *Ephemeris* and the *Nautical Almanac* omit predictions for a day or so before and after full moon, and do not seem to consider the possibility of occultations during lunar eclipses. So they neglected to predict this one. In "Planetary Phenomena in 1938" (*P. A.*, Jan., 1938, p. 39) a list of occultations of Uranus for this year was given, but this one was omitted. However, as the author of the article stated, the data were taken from the *Ephemeris*.

WESTON COLLEGE, WESTON, MASSACHUSETTS, NOVEMBER, 1938.

Planet Notes for January, 1939

By R. S. ZUG

NOTE: Greenwich Civil Time is employed, unless otherwise stated. To obtain Eastern Standard Time subtract 5 hours, Central Standard Time, 6 hours, etc. The planetary phenomena are described as they are to be seen from latitude 45° N. The data are taken chiefly from the *American Ephemeris and Nautical Almanac*.

Sun. The positions of the sun for January 1 and January 31, respectively, are: $\alpha = 18^h\ 42^m1$, $\delta = -23°\ 5'5$; $\alpha = 20^h\ 50^m7$, $\delta = -17°\ 41'2$. The sun is in the constellation Sagittarius until January 19, on which day it enters the constellation Capricornus. It remains in the latter constellation for the remainder of the month. The earth is in perihelion on January 3, 22^h. The distance from the earth to the sun on that date will be 91,340,000 miles. Values for the equation of time are as follows:

Date 1939	Equation of Time (Mean - Apparent) m s	Date 1939	Equation of Time (Mean - Apparent) m s
Jan. 3	+ 4 3	Jan. 19	+10 28
7	+ 5 52	23	+11 39
11	+ 7 33	27	+12 38
15	+ 9 6	31	+13 23

Moon. Phenomena of the moon will occur as follows:

		h m
Full Moon	Jan. 5	21 30
Last Quarter	12	13 10
New Moon	20	13 27
First Quarter	28	15 00
Perigee	6	11
Apogee	20	23

Mercury. Mercury will be in greatest elongation west (22° 49′) on January 3, 10^h, but poorly placed for observation. While near greatest elongation it rises at azimuth 300°, and reaches an altitude of 12° by time of sunrise.

Venus. Venus will be a brilliant morning star during January, although situated rather low in the southern heavens. The planet attained its greatest brilliancy on December 26 with a stellar magnitude of —4.4, but there is not much diminution in brightness during January, the magnitude being —4.1 on January 31. A greatest western elongation of 46° 56′ will occur January 30, 13^h. On this date the planet will rise about three hours before the sun, in azimuth 300°, and by sunrise it will have advanced to azimuth 340°, altitude 20°.

Mars. Mars begins the month as a morning star in the constellation Libra. On the morning of January 3 the planet will be situated about a half degree north of the 2.9 magn. star, α Librae. The eastward motion of Mars continues through January, taking the planet into the constellation Scorpius by the end of the month. On January 31, Mars will be found a little over a degree east of the 2.9 magn. star, β Scorpii. The planet will be found near the meridian at sunrise, during January. The angular diameter of Mars increases from 4″.8 to 5″.6 during the month, while the stellar magnitude varies from +1.7 to +1.4. An occultation of Mars by the moon occurs January 14, 21^h, which is, however, invisible from the American continents.

Jupiter. Jupiter moves slowly eastward in the constellation Aquarius during January, its line of motion being close to the ecliptic circle. The stellar magnitude of the planet will remain —1.6 during January.

Jovian satellites X and XI, discovered recently by Dr. Seth B. Nicholson, have proven to be of unusual interest. The orbit of Jupiter X is related in what seems to be a remarkably significant manner to the orbits of VI and VII. The three orbits form a symmetrical interlocking group, each with practically the same inclination, eccentricity, and semi-major axis. The periods of revolution of X, VI, and VII, are respectively, 260.5, 250.57, and 259.65 days.

Jupiter XI and VIII and IX seem similarly inter-related. The satellites of this second group are about twice as far from Jupiter as those of the first group, and are all retrograde. The orbits of XI, VIII, and IX are quite comparable with each other in inclination, eccentricity, and semi-major axis. The orbital periods are, respectively, 692.5, 739, and 758 days. An informative discussion of the orbital relationships in these two satellite groups, written by Paul Herget, appeared in POPULAR ASTRONOMY for November, 1938, p. 509. Dr. Herget has computed orbits for both the newly discovered satellites, and, so far as I am aware, was the first to point out the significant orbital relationships mentioned above.

Saturn. Saturn is in eastern quadrature with the sun on January 2. The planet moves about a degree eastward during the month, and is situated very near the southern boundary of the constellation Pisces. The stellar magnitude of Saturn is +0.9 during January.

Uranus. Uranus is in slow retrograde motion until January 23, the motion then becoming direct. The planet is situated in the constellation Aries, and during January may be found by searching one degree to the north of, and a half degree to the west of, the 5.5 magn. star, σ Arietis. The positions of Uranus for January 1 and January 31, respectively, are: $\alpha = 2^h\,46^m.7$, $\delta = +15°\,42'.3$; $\alpha = 2^h\,46^m.1$, $\delta = +15°\,40'.0$. An occultation of Uranus occurs January 29, 2^h (See "Occultation Predictions" in this issue).

Neptune. Neptune is in the constellation Leo, and rises a little before midnight. A chart appeared in "Planet Notes for December, 1938," illustrating the path of Neptune among the stars for the 1939 observing season.

Occultation Predictions

(Taken from the *American Ephemeris*)

Date 1939		Star	Mag.	IMMERSION Greenwich C.T.	IMMERSION *a*	IMMERSION *b*	IMMERSION Angle E from N	EMERSION Greenwich C.T.	EMERSION *a*	EMERSION *b*	EMERSION Angle E from N
				h m	m	m	°	h m	m	m	°
OCCULTATIONS VISIBLE IN LONGITUDE +72° 30′, LATITUDE +42° 30′.											
Jan.	3	333 B.Tau	6.5	22 57.1	—0.6	+1.6	78	0 2.4	—1.1	+1.1	267
	4	107 Tau	6.5	0 30.2	—1.3	+1.1	87	1 43.6	—1.6	+0.8	262
	4	353 B.Tau	6.4	6 49.0	—0.9	—1.1	91	7 51.2	—0.4	—1.6	282
	7	84 B.Cnc	6.4	7 55.3	..	..	46	8 22.7	..	..	0
	8	ω Leo	5.5	4 51.2	—1.3	—0.5	128	6 2.0	—1.7	+0.2	277
	10	388 B.Leo	6.3	9 31.2	—1.7	—0.9	113	10 47.3	—1.3	—1.6	304
	11	78 B.Vir	6.5	5 21.9	—0.4	0.0	130	6 25.7	—1.0	+0.8	281
	12	50 Vir	6.2	7 11.4	—1.2	+1.1	95	8 18.7	—0.9	—0.5	317
	29	Uranus	6.1	2 53.9	—1.0	—0.4	66	3 58.7	—0.4	—1.6	276
	29	26 B.Tau	6.4	20 23.9	—0.3	+2.9	34	21 19.2	—1.7	+0.1	292
	31	312 B.Tau	6.2	7 28.5	0.0	—0.8	73	8 16.2	+0.5	—1.5	294
OCCULTATIONS VISIBLE IN LONGITUDE +91° 0′, LATITUDE +40° 0′.											
Jan.	3	234 B.Tau	6.0	9 49.8	+0.6	—2.7	146	10 20.1	—0.3	+0.5	217
	3	333 B.Tau	6.5	22 47.7	0.0	+1.7	66	23 43.2	—0.6	+0.9	278
	4	107 Tau	6.5	0 9.5	—0.6	+1.6	77	1 14.7	—1.1	+1.0	268
	4	351 B.Tau	6.2	5 43.0	—2.0	+1.5	49	6 36.5	—1.1	—3.1	318
	4	353 B.Tau	6.4	6 31.3	—1.3	—1.6	114	7 38.9	—1.3	—0.6	257
	7	84 B.Cnc	6.4	7 9.6	—2.0	+0.3	87	8 18.4	—1.3	—2.0	317
	7	A^2 Cnc	5.7	14 1.3	..	..	34	14 14.8	..	..	3
	8	ω Leo	5.5	4 33.8	—0.9	—1.0	145	5 28.6	—1.4	+1.7	253
	10	388 B.Leo	6.3	9 6.8	—1.2	—1.4	145	10 18.1	—2.1	—0.2	274
	11	78 B.Vir	6.5	5 19.6	0.0	—0.8	149	6 6.8	—0.6	+1.8	256
	12	50 Vir	6.2	6 57.6	—0.3	+0.3	121	8 1.6	—0.8	+0.6	288
	28	o Ari	5.8	23 37.9	..	..	152	23 51.7	..	..	169
	29	Uranus	6.1	2 30.2	—1.6	—0.4	78	3 47.4	—1.2	—0.8	259
	31	312 B.Tau	6.2	7 29.2	—0.2	—1.3	96	8 25.2	+0.1	—2.1	272
OCCULTATIONS VISIBLE IN LONGITUDE +120° 0′, LATITUDE +36° 0′.											
Jan.	3	ϵ Tau	3.6	11 21.2	+0.6	—3.1	150	11 50.1	—0.6	+0.9	214
	4	107 Tau	6.5	0 0.6	+0.4	+1.7	56	0 48.9	—0.4	+0.6	288
	4	351 B.Tau	6.2	4 40.9	—1.6	+1.8	62	5 53.0	—2.1	—0.8	291
	4	353 B.Tau	6.4	5 46.8	—2.3	—2.7	140	6 39.5	—2.2	—3.0	219
	7	84 B.Cnc	6.4	6 20.7	—1.3	0.0	117	7 32.2	—1.7	+0.4	276
	7	A^2 Cnc	5.7	13 44.4	—0.8	—0.9	84	14 36.1	0.0	—2.1	320
	8	ω Leo	5.5	4 21.7	—0.4	—1.4	156	4 56.5	—0.1	+2.7	234
	15	47 Lib	5.9	12 6.1	..	..	41	12 35.5	..	..	352
	28	12 H^1. Ari	6.3	6 15.4	..	..	4	6 33.9	..	..	331
	29	Uranus	6.1	1 29.8	—2.1	+1.2	71	2 57.6	—2.2	+0.6	250
	31	312 B.Tau	6.2	7 23.4	—0.6	—3.1	140	8 11.3	—1.5	+0.7	228

The quantities in the columns *a* and *b* are given for the purpose of making these predictions useful for any place within 200 miles of the point indicated. The procedure is as follows: Subtract the longitude of the point given from the longitude of the place in question; multiply the result in degrees, taking the

signs into account, by the quantity under *a* for the star to be observed; similarly, with the latitude, using *b*; apply the sum of the products, with its proper sign, to the Greenwich C.T., and obtain the predicted Greenwich Civil Time for the phenomenon at the place of observation. To obtain Eastern Standard Time it is necessary to subtract five hours; Central Standard Time, six hours, etc.

METEORS AND METEORITES

Meteor Notes from the American Meteor Society

By CHARLES P. OLIVIER, President

As the moon was mostly out of the way, conditions for observing the Orionids during the past October were favorable. It is never possible this soon after a shower has appeared to give a full account of the results by our members, for many of them send in their reports late. However, we have already heard from 11 stations, where from one to three persons observed. The rates were average but the proportion of bright meteors was large, basing this remark upon the results of those who used the regulation blanks and maps, and did not merely count for rates. In this connection, I have been working for the past three years on the problems concerning long enduring trains. It has struck me that a good many meteors, leaving these appendages which remained visible from one to several minutes, or showed drift, were Orionids. In the October, 1938, record, to date, I have found one such sporadic meteor but no Orionid.

This opportunity is taken to urge once more upon all readers to spare no effort in making full records of such trains. What is wanted, besides the path and general description of the train-producing meteor, is a clear account of the direction and angular velocity of drift of the train. This is best accomplished by drawing it on a star-map at one minute intervals. If no such map is available, make the best written (or mental) notes possible and then transfer to a map as soon as possible. An opera-glass or field-glass should be used on any train lasting as long as 10 seconds, as, with its help, sometimes the observable duration will run to a minute or more. I beg of everyone, whether interested in meteors or not, to please send me any records he has on such trains from the past or any he may be fortunate enough to secure in future. A few radiants derived from this year's work are now given: all the maps received have not been worked up.

Radiant A.M.S. No.	Date 1938	α °	δ °	Number Meteors	Observer
2995	Oct. 21.75	92	+15	5	G. Green
2996	19.85	90	+14	7-11	C. McArthur
2997	19.73	93	+17	4-11	R. Mastell
2998	19.72	91.5	+15.5	9+	G. Pirsig

Now follows the table giving the details for rates. From his own observations, Loreta has drawn a curve and finds the maximum would have come on October 22/23. During the last 30 to 40 years there certainly seems to have been a tendency for the date of maximum to become later.

Observer and Station	Date Oct.1938	Began	Ended	Total Min	Ori	Sp	Ttl	F	Nt
E. Loreta, Bologna, Italy	17/18	10:00	12:25	100	5	11	16	...	v
	18/19	9:00	11:25	125	4	13	17	...	
	19/20	10:00	11:25	75	3	10	13	...	
	20/21	10:00	11:25	75	19	9	28	...	

Observer and Station	Date Oct.1938	Began	Ended	Total Min	Ori	Sp	Ttl	F	Nt
E. Loreta, Bologna, Italy	21/22	10:00	14:25	225	106	47	153	...	
	23/24	10:00	13:55	200	76	49	125	...	
	24/25	10:00	13:25	175	34	39	73	...	
R. M. Dole, Scarboro, Maine....	18/19	12:30	14:26	96	..	..	32	0.9	B, C
G. Green, Pittsfield, Massachusetts	21/22	11:27	14:36	189	..	..	29	0.5	V
W. Falce, Pittsfield, Massachusetts	21/22	9:50	14:35	?	..	..	13	0.5	V
F. H. Sherman, Levanna, N. Y...	22/23	16:30±		10	20±		20±	...	B, D
G. H. Euart, Providence, R. I....	19/20	13:00	15:00	115	22	1	23	0.8	B
J. L. Euart, Providence, R. I.....	19/20	13:00	15:00	110	28	5	33	0.8	B
F. Preucil, Joliet, Illinois.....	20/21	10:30	11:30	60	7	6	13	1.0	B
J. E. Ulrich, Louisville, Ky.....	20/21	12:00	13:00	60	..	..	23	...	B
W. L. Moore, Louisville, Ky.....	20/21	12:00	13:00	60	..	..	38	...	B
Miss M. Shapinsky, Louisville, Ky.	20/21	12:00	13:00	60	..	..	39	...	V
G. McArthur, N. Quincy, Mass...	18/19	14:15	16:48	128	13+	..	30	0.8	V
R. Mastell, Hibbing, Minnesota..	19/20	10:00	13:00	180	11	7	18	0.5	V
G. Pirsig, Blue Earth, Minnesota	19/20	10:18	12:18	120	20	8	28	0.9	V
W. R. Stone, Santa Barbara, Calif.	18/19	11:00	14:00	180	10	8	18	1.0	V
	19/20	11:00	14:00	180	9	8	17	1.0	V
	20/21	11:30	13:00	90	5	6	11	0.6	V

FOOTNOTES

V meteors plotted, in whole or part.
B meteors were counted only.
C Dr. W. L. Holt recording.
D saw 15 to 25 meteors in 10 minutes.

I have just had the pleasure of receiving seven Russian publications through I. S. Astapowitsch, himself the author of several of them. Though the texts are in his language and hence unreadable by me, fortunately there are English résumés for most of them, and enough equations in the articles themselves to make them partly, if not wholly, intelligible when enough study has been put upon them. I have not yet had time to do this but the conclusions of S. Orlov in his paper, "Apparent Radiants of Cosmic Meteor Showers," in *Astr. Jr. of Soviet Union*, XIII, 5, are so interesting that I quote them. It helps drive one more nail into the coffin of "stationary radiants" but is principally important because it solves a more general problem as will be seen in the following quotation: "In the present paper is solved the following general problem: meteors are moving as a continuous shower with velocity H (at a definite distance from the sun) from the interstellar space along parallel lines; their true radiant has any coördinates β and λ. One must find the position among the stars of the apparent radiants of this cosmic shower in the course of the whole year. A formula is given for the computation of the positions of the apparent radiant. The solution of the problem in the general form allows one to find out some new curves of apparent radiants in the problem solved (by) Knopf (particular case: the true radiant of the shower lies in the plane of the ecliptic; *A.N.* 242, 162). For the true radiants $\beta = 90°$, 50°, 10°, and 0°, curves were drawn on celestial charts determining the position of apparent radiants in the course of the year. It was found that the apparent radiants of each shower (except $\beta = 0°$) are distributed over two closed curves, lying in the north and south hemisphere of the ecliptic, respectively. Thus it is possible to study from observations of the meteors on the north hemisphere alone the distribution of the cosmic showers, lying anywhere in the south hemisphere. Stationary radiants remaining during 72 days in the limited plane of radiation (radius 3°.3) may lie outside of the ecliptic ($\beta = 11°$)."

The tremendous activity of the Russian observers, both amateur and profes-

sional, sets a pace in meteoric astronomy that is most difficult to match in any other country. Most of us could wish that they would publish in some other language than their own, so that their work would be more widely available, but this is too much to expect in these days of intense nationalism. In any case I advise all persons who can to examine files of the journal mentioned as well as of "Bulletin of the Observers Corporation of the Astronomical-Geodetical Society of the U.S.S.R.," for work of value in many phases of meteoric astronomy will be found.

We would like more observations on two brilliant fireballs; the first 1938 October 18, 8:50±5, E.S.T., seen in Pennsylvania and West Virginia; the second on October 27, 7:55±, E.S.T., seen in Florida. The second is doubly important because the train lasted several minutes. Our regional director for New York, C. H. Smith, has recently worked up the data on the 1938 July 26 fireball which appeared over eastern New York. His results are now being checked here for publication. He deserves great credit for a time-consuming task, well done.

This paper should appear in plenty of time for persons to be asked to observe the Geminids, the second richest shower of the average year. Their maximum usually comes on December 12/13, but they are numerous for two days before and after. I hope all A.M.S. members will observe; the moon will be at last quarter and therefore somewhat troublesome, but not too much so. In passing, may I say that at the present time we have few if any observers who seem able or willing to observe a shower several nights in succession and stay up 3 to 5 hours each so that really *excellent results* can be obtained. There is plenty of room in our subject for a number of such persons, who would incidentally become very skillful by much practice. We have had them in the past, why cannot some new men step forward to take the places of those whom circumstances have forced out?

Flower Observatory, Upper Darby, Pennsylvania, 1938 November 8.

Contributions of the Society for Research on Meteorites

Edited by FREDERICK C. LEONARD,
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The Pantar, Lanao, Philippine Islands, Meteorite

By H. H. NININGER

Abstract.—A 2,320-gram aërolite which was observed to fall on June 16, 1938, at Pantar, Lanao, Philippine Islands, by Mr. R. H. Wygle, is described as being of the ordinary chondritic variety. Mr. Wygle was extremely fortunate also in securing a photograph (herewith reproduced) of the dust cloud which appeared in the wake of the meteorite. There was a press report to the effect that, at the time of the fall of the meteorite, many small particles fell like rain onto the metal roofs of several houses. There is no reason to doubt this report, for a similar occurrence has been recorded in connection with at least four North-American falls. That this phenomenon is in some way related to meteoritic clouds is reasonable to as-

sume. If the connection is established, then ordinary meteoritic showers will have to be reckoned, probably in *tons*, instead of *grams*, of material!

The fall of the Pantar, Lanao, Philippine Islands, meteorite was first reported to the writer through Professor F. M. Van Tuyl of the Colorado School of Mines. His information came from Mr. R. H. Wygle of Cagayan, Misamis Or., Philippine Islands, who not only was an eyewitness to the event, but also made a valuable contribution to the science of meteoritics by photographing the dust cloud which appeared in the wake of the meteorite. The fall is said to have taken place on June 16, 1938. The hour of arrival was not stated, but it took place presumably in daylight hours, since the account states that one stone was seen to land in a rice field and was later extracted from a depth of one meter. Its weight was given as 2,320 grams. Mr. H. J. Detrick was responsible for its preservation and for delivering it to the Governor of Lanao.

A small specimen weighing 16.8 grams has been examined by the writer and has been found to be of the ordinary chondritic variety. The interior is of a gray

THE METEORITIC CLOUD OF THE PANTAR METEORITE
A photograph taken, apparently through atmospheric clouds, by R. H. Wygle about a minute after the meteor caused by the Pantar meteorite appeared.

color except where stained brown from the incipient oxidation of some of the nickel-iron grains which are very abundant in the stony matrix. The chondrules, which constitute a large part of the stony matrix, are small in size, rarely more than one mm. in diameter in the specimen examined. The matrix appears to be a breccia of two different materials which differ only slightly in color—one a darker gray than the other. In the darker member the chondrules break with the matrix, while, in the lighter-colored one, they survive the breaking of the mass. Dark,

thin veins permeate the stone in several places. The nickel-iron grains are plentiful and are of about the same average size as those in the Beardsley, Kansas, fall of 1929. They are extremely irregular in form. Sulphide grains are small and not very numerous in the specimen examined. The specimen at hand is covered by the usual dull, brownish-black fusion crust, which is scarcely more than one-tenth of a mm. in thickness.

Two very important things have been secured in connection with this fall. The first is the photograph of the dust cloud obtained and delivered by Mr. Wygle. This photograph is herewith reproduced. Discussion of the apparently vaporous clouds surrounding the meteoritic cloud must await a more detailed report by Mr. Wygle. If these *are* vapor clouds, then the meteoritic cloud must have been very distinct indeed to show so clearly through them. Meteoritic clouds are not known to develop lower than about seven or eight miles. The distance of this cloud from the photographer was not reported, but Mr. Wygle did report that the sound of "a series of explosions" arrived about sixty seconds after the flash of the meteor. He also described the smoke as being of an old-rose color. Such photographs as this one (made apparently with an ordinary kodak) are very rare, and yet they are extremely important in the science of meteoritics. It is hoped that more will be made as falls take place in the future.

Second, a very important fact recorded in connection with the Pantar fall is taken from the press reports and has not yet been verified, but there is no reason for doubting its occurrence, since at least four other similar cases have been cited for North-American falls. This is the report that small particles fell like rain onto the metal roofs of several houses. It is hoped that this report may later be verified and that the extent of this shower also may be determined. The writer has several times expressed his belief that this kind of phenomenon is the most important of all of those to be investigated in connection with meteoritic falls. That it is related to meteoritic clouds is reasonable to assume. If this relation is proved to exist, and if the extent of the phenomenon is discovered to be comparable to the dimensions of these clouds, then ordinary meteoritic showers will have to be thought of eventually in terms of *tons* instead of *grams* of material!

Meteoritical Proofs of the Earth's Motions

By SAMUEL HERRICK, JR.,
Department of Astronomy, University of California at Los Angeles

One hesitates to write upon a matter which will seem obvious to any astronomer; yet the fact is that the literature of astronomy, with no exception that has come to the writer's notice, cites as merely *consequences* of the earth's rotation and revolution certain meteoritical phenomena which might well be included instead among the *proofs* of these motions.

Chief among these phenomena is the more frequent appearance of meteors in the hours after midnight as compared with those before. C. P. Olivier gives on p. 182 of his *Meteors* (1925) a compendium of data on the frequency of meteors at various hours of the night, which indicates that they are about twice as frequent at 6:00 A.M. as they are at 6:00 P.M. It appears difficult to find any natural explanation for this phenomenon other than the usual one: namely, that rotation brings us in the morning hours to the forward side of an eastward-moving earth, and that this side is likely to sweep up more random meteoritic particles than the other.[1]

As a proof of the earth's revolution, this phenomenon compares favorably

with annual aberration, annual parallax, and the variation of stellar radial velocities, since any person may verify it for himself with a night or two of naked-eye observations and a moderate understanding of probability and statistics.[2] One may regret that the statistical method was not a usual part of the equipment of the scientific mind at the time of Aristarchus, since this phenomenon, if recorded, might well have suggested to him the necessary hypothesis as to the nature of meteors and the resulting evidence for his theory of the earth's motions.

Additional evidence on this point may logically be sought in the velocities (and colors) of meteors and the frequency of meteorite falls. Statistics are not readily available on the former point, although it is generally accepted that the velocities are greater and the colors bluer in the hours after midnight. The most recent tabulation of the hour frequency of meteorite falls is given by Professor Mohd. A. R. Khan (*C.S.R.M.*, 1938: *P. A.*, **46**, 51-4; and **2**, No. 1, 5-8). This does not show a preponderance of meteorite falls in the A.M. hours because of the influence of two other factors. One of these, the greater awareness of people in daylight and early evening hours, cannot be eliminated as in the case of prearranged meteor observations. The other, the greater rate of consumption of meteorites in the A.M. hours,[3] because of their higher velocities relative to the earth's atmosphere, is itself a consequence (and to some extent an evidence) of the earth's motions.

The foregoing argument applies chiefly to the revolution of the earth around the sun, but it should be noted that the earth's axial rotation also is implied and affirmed.

FOOTNOTES

[1] W. H. Pickering calculates that the earth should sweep up six times as many meteoritic particles at sunrise as at sunset, if they are traveling with random parabolic velocities. Accordingly, he concludes that the greater part of them shares the eastward motion of the planets (*P. A.*, 1910, **18**, 276).

[2] The presence of probability and statistics in the argument may be indeed the principal justification for its introduction in the classroom, since they are increasingly emphasized as a part of a general education. See the recent address of C. G. Darwin before Section A (Mathematical and Physical Sciences) of the British Association for the Advancement of Science, *Nature*, 1938, **142**, 381-4.

[3] H. H. Nininger finds in confirmation of this an average weight of 31.1 pounds for forenoon falls as compared with 58.3 for afternoon falls (*Our Stone-Pelted Planet*, 1933, p. 25). It is possible, of course, that the larger meteorites may tend to revolve around the sun in the eastward direction even more than the smaller ones.

Recording the Time and Place of Fall and the Designation of Meteorites

Both the *date* and the *Greenwich Civil Time* (G.C.T.; called also "World Time" *etc.*)—as accurate as this is determinable—of every witnessed meteoritic fall should be recorded. The *date* of discovery of every non-witnessed fall (or so-called "find") likewise should be registered. The geographical coördinates, longitude (L) and latitude (ϕ), of the exact location of a fall (whether observed or not), should be given with the highest possible precision. The latter data are obtainable frequently, if in no other way, from a large-scale topographical map. It is recommended that the longitude be expressed to at least the nearest second of time (or fifteen seconds of arc) and the latitude to the nearest tenth of a minute of arc.

Every meteoritic fall should be designated by the *full name of the postoffice* nearest the place of its occurrence, unless there be no postoffice within a radius of several miles of the spot; in that case, the name of the smallest political subdivision

should be used in lieu of a postoffice name. If the fall occur within the United States, the name of the county and of the state; or, if it take place elsewhere, the name of at least the main political subdivision and of the country, should always be included in the official designation of the fall (*e.g.*, "Muroc, Kern County, California"; "Springwater, Saskatchewan, Canada"; "Rowton, Wellington, Shropshire, England").

If more than one distinguishable fall should occur at a place, all such falls should bear the *same geographical name*, and, further, should be *numbered* in the chronological order, and *dated* with the year, of their discovery (as, *e.g.*, "Holbrook, Navajo County, Arizona, No. 1, 1912," "Holbrook, Navajo County, Arizona, No. 2, [year]," *etc.*, if more than one recognizable fall should become known at that location).

The distinction between the terms *meteorite* and *fall* (*v.* the writer, "Further Remarks on Meteoritical Terminology," *C.S.R.M.*, 1937: *P. A.*, **45**, 45-50; and **1**, No. 3, 1-6, fifth paragraph) should be preserved. A "multiple fall" or "meteoritic shower" may be defined as a fall consisting of two or more complete individual meteorites. The form, dimensions, and orientation of the area covered by a shower, and the exact position of each individual within the area, should be shown on a map. The announcement of every new fall should contain full information concerning the total number, the classification, and the weights of the recovered masses.

Members of the Society for Research on Meteorites and contributors to its publications are urged hereafter to follow these practices, in recording the time and place of fall of, and in naming, describing, and referring to meteorites and meteoritic showers, especially new ones. There is no occasion for uncertainty or ambiguity in the designation of a fall for which the essential data are available; and it need hardly be added that inaccurate or incomplete information greatly impairs the scientific value of any report.

FREDERICK C. LEONARD

Terminology Again!

In *P. A.*, 1938, **46**, 521-2, under the caption of "Definitions in Meteoric Astronomy (Second Note)," Dr. C. C. Wylie mentions a communication by myself entitled "A Glossary of Terms in Meteoritics," *N.S.R.M.*, *P. A.*, 1934, **42**, 477-8. For the benefit of the readers, mainly of *P. A.*, I should like to point out that that note was *entirely* superseded by a later paper, "Further Remarks on Meteoritical Terminology," *C.S.R.M.*, 1937: *P. A.*, **45**, 45-50; **1**, No. 3, 1-6. Practically all the terms and definitions advocated in that paper (only a few of which were original with me) received the official endorsement of the members of the Committee on Terminology of the S.R.M. (of which Dr. H. H. Nininger was Chairman and I was not a member), present at the meeting of the Committee held at the Fifth Annual Meeting of the Society in Denver, Colorado, in June, 1937. Accordingly, these terms and their definitions—which are anything but "loose" to one who understands them—have since been consistently employed throughout the *C.S.R.M.* and so they will continue to be.

The use of *dictionary* definitions of technical terms in any field of knowledge is at best and for obvious reasons a dubious practice. As an illustration of this thesis, consider the standard dictionary definition of *astronomy* itself—a definition unfortunately perpetuated by many otherwise excellent textbooks—"the science of the heavenly bodies," which would do almost as well for *angelology!* F.C.L.

The Sixth Annual Meeting

Attention is called to the announcement in the November issue (p. 525), of the Sixth Annual Meeting of the Society, which will occur on the morning and afternoon of December 29 and 30, 1938, in conjunction with the convention of the A.A.A.S. at Richmond, Virginia. Two special features of this meeting are the joint session with Section E (Geology & Geography) of the Association, on "The Origin of the Carolina 'Bays,'" which will take place on December 29, probably in the morning, and an invited paper, to be delivered at one of the independent sessions of the Society, by Dr. Joseph Kaplan of the Departments of Physics and Astronomy of the University of California at Los Angeles, on "Recent Advances in our Knowledge of the Earth's Upper Atmosphere," a subject closely allied to meteoritics and so of much interest to meteoriticists. Members are requested kindly to note that the *titles and abstracts* of all papers which are intended to be presented at the meeting, should be in the *Secretary's* hands, *not later than November 26*, if they are to appear on the *printed program*.

VARIABLE STARS

Variable Star Notes from the American Association of Variable Star Observers

By LEON CAMPBELL, Recorder

More About Novae: Observations of new stars continue to be a subject of interest to amateur and professional alike. A recent paper by Dr. M. L. Humason of the Mt. Wilson Observatory dealing with the observations, mainly spectroscopic, of sixteen old novae, brings out some interesting facts.

The most striking feature which he brings to our attention is the hypothesis that T Coronae Borealis, which attained the second magnitude in 1866, is a faint blue companion to the tenth magnitude red star which has been observed visually for many years. He arrives at this conclusion from the examination of several facts.

Without exception, all other novae which have been observed are now blue stars. The spectral type of T Coronae Borealis has been classed as Mb, whereas all other old novae belong to Class O, with continuous spectra or emission lines, indicated by "Con" or "Em."

Again, the temperature of an M-type star would be far too low to excite a line with an excitation potential as high as that of λ 4686 which is now observed in the spectrum. Also, the bright lines do not have the same displacement as the absorption lines.

During the early stages of the outburst of T Coronae Borealis, the light curve was typical of many other novae. When the decreasing light reached visual magnitude 10.0, however, it suddenly became constant, except for slight fluctuations, and has continued to remain at that magnitude ever since.

Visual observations during the past twenty years, especially those by L. C. Peltier, show little if any variation from magnitude 9.8. On the other hand, Dr. S. Böhme of Bamberg reports that since 1936 the star has shown evidence of variation in photographic light of almost a magnitude. If this fact is confirmed, it would seem to indicate that the blue component varies to a small extent, but that the variation is not apparent in the visual portion of the spectrum, and that visual

observers see only the non-varying red star. This would be another point in favor of the conclusion that T Coronae Borealis is the faint blue component of a binary star, the other brighter component being the tenth magnitude red star.

In 1932 Dr. L. Berman suggested that T Coronae Borealis may be a double object of this sort. The Gaposchkins, in their forth-coming book on variable stars, offer the further suggestion that this nova may have undergone outbursts previous to that of 1866. It is reported that John Herschel recorded a sixth magnitude star near the same position, in June, 1842. Accordingly, the identification of T Coronae Borealis as a B.D. star would seem to refer to the cataloguing of the red component rather than to the nova itself. From an examination of 99 plates covering the years 1932 to 1938, Dr. S. Gaposchkin does not confirm the range of a magnitude observed by Böhme, although there are changes amounting to a few tenths of a magnitude, especially in March and May of this year.

Other facts brought out by Humason relate to the density of Nova Persei, 1901, as being two hundred and twenty times that of the sun, and Nova Aquilae, 1918, as seventy times. The mean density of eleven novae, whose distances are reliably known, proves to be about sixty times that of the sun.

In spite of repeated efforts on the part of astronomers, B Cassiopeiae, Tycho's famous star of 1572, and Nova Vulpeculae of 1670, have not been positively identified. Perhaps this task will be one to which the attention of astronomers may turn upon the completion of the 200-inch glass.

During the past year, Nova Herculis, 1934, has continued slowly to decrease in light, from magnitude 8.5 to 9.0, at the rate of a tenth of a magnitude in two months. This value agrees remarkably well with the average rate of decrease since September, 1935, when the star was at magnitude 6.7, of a tenth of a magnitude in fifty days.

RS Ophiuchi, 1744*o6*, with two outbursts to its credit in 1898 and 1933, has been varying since it reached minimum in February, 1934, between magnitudes 12.3 and 10.5. Maxima are indicated at J.D. 2427830, 8075, 8425, and 9010. Minima appear at J.D. 2427475, 7960, 8235, and 8675. This fluctuation in light after the star had reached minimum is quite in contrast to the behavior of the star for some years prior to its 1933 outburst, when the light was practically constant, at magnitude 11.0. At present, RS Ophiuchi is at visual magnitude, 11.5. The star may be experiencing a period of slight activity which perhaps will eventually die out. It may then appear constant at about the eleventh magnitude, its present mean brightness.

R Coronae Borealis Type Variables: Three of the four R Coronae Borealis type stars now being observed by the A.A.V.S.O. continue to pursue what might be termed an erratic course. A month ago R Coronae Borealis appeared to be on the way to normal maximum. But having attained magnitude 7.4, about October 20, the variable almost immediately began to diminish in light and by November 11 it had steadily fallen to below the twelfth magnitude. Such procedure on the part of stars of this peculiar type is not unprecedented.

SU Tauri, having reached a minimum magnitude of 14.6 late in September, began to increase in brightness early in October, and by November 1 had recovered most of its light, reaching magnitude 10.4.

RY Sagittarii, which began to decrease in magnitude on October 8, had dropped to magnitude 11.4 by October 24. All three of these variables demand our closest attention, not only to their light changes but to their spectral variation as well.

New Japanese Variable Star Report: An excellent contribution from the Japanese variable star observers has just appeared as Report No. 1 of the Variable Star Section of the Oriental Astronomical Association. This report, printed in mimeograph form, contains 248 pages and represents the work of 33 Japanese observers. The observations are concentrated on 194 stars, and number nearly 22,000. While the report contains principally observations made during the year 1936, there are also found many hitherto unpublished earlier observations.

Included among the variables observed are many of long period, RV Tauri type, R Coronae Borealis type, SS Cygni type, and recently discovered novae. That this compendium of observational data will add materially to our already existing information cannot be denied. Many gaps in light curves are sure to be filled, and doubtful portions of curves made more certain.

Pleione: The recent announcement by Dr. D. B. McLaughlin of Ann Arbor that a spectrogram taken on October 28, 1938, showed the return of the bright hydrogen lines in the spectrum of Pleione, after an absence of thirty-two years, is particularly interesting. Such behavior is known to occur in only a few stars. During this interval of thirty-two years—at least up to 1936—the spectrum of Pleione remained conspicuously an absorption type. Sometime during the past two years the spectrum changed from a very diffused absorption type to a composite one similar to that of ϵ Capricorni.

In 1926, Dr. B. P. Gerasimovič called attention to the similarity in spectra of Pleione and μ Centauri. Prior to 1918 the spectrum of μ Centauri showed a gradual decrease in intensity of the hydrogen emission lines, and in the next year they had entirely disappeared. Accompanying this change in spectrum from emission to absorption there was a noticeable diminution in brightness of the star, amounting to between one and two tenths of a magnitude.

Dr. W. A. Calder in 1935-37, while measuring brightness of the Pleiades with a photo-electric cell at Harvard, found that Pleione showed evidence of having become fainter in that interval of time. He stated in 1937 that the star had formerly shown emission lines resembling the old nova, P Cygni, but that in recent years these lines had disappeared.

It would seem that in Pleione and in μ Centauri we have changes in spectra from absorption to emission, which are accompanied by slight diminution in intrinsic brightness. The suggestion is made that perhaps Pleione, star No. 7 in the Pleiades, may be the "Lost Pleiad." It will be of interest to note whether or not the star will increase in brightness, now that it has again revealed emission lines.

Observers and Observations during October, 1938: New contributors during the past month are: D. S. Kimball of the New Haven Amateur Astronomical Society, and Professor F. H. Reynolds of Clarkson College, Potsdam, New York. A tabulation of the October contributions follows:

Observer	Var.	Est.	Observer	Var.	Est.
Albrecht	5	5	Cameron	4	5
Ancarani	12	18	Dafter	12	31
Baldwin	93	123	Diedrich	33	45
Ball, A. R.	9	12	Economou	3	7
Ball, J., Jr.	4	4	Ensor	65	92
Blunck	38	44	Escalante	70	111
Bouton	45	59	Evans	13	13
Brocchi	17	46	Fairbanks	14	14
Buckstaff	19	51	Fernald	33	131
Callum	47	86	Ford	3	3

Observer	Var.	Est.	Observer	Var.	Est.
Franklin	32	58	Monnig	16	16
Gaposchkin	1	9	Murphy	9	10
Gomi	2	23	Needham	27	32
Gregory	105	152	Parker	20	20
Halbach	56	61	Peltier	202	269
Hartmann	113	119	Prinslow	10	12
Herbig	154	492	Purdy	9	12
Hiett	16	45	Rademacher	4	4
Hildom	43	105	Recinsky	11	40
Holt	72	82	Reynolds	3	6
Houghton	76	121	Rosebrugh	20	92
Howarth	7	8	de Roy	17	71
Irland	4	4	Russell	20	25
Jones	102	390	Ryder	12	12
Kanda	3	20	Seely	15	47
Kearons	41	69	Shafer	5	7
Kelly	12	22	Sill	71	84
Keuziak	11	16	Smith, F. P.	34	38
Kimball	4	4	Smith, F. W.	2	3
Kirkpatrick	31	80	Smith, J. R.	28	28
de Kock	53	250	Treadwell	22	50
Kazawa	16	80	Webb	43	56
Loreta	168	750	Williams	9	38
McLeod	32	75	Woods	18	33
Meek	51	254	Yamasaki	13	16
Millard	26	37			
			Total Observations		5247

November 18, 1938.

Notes from Amateurs

The Cleveland Astronomical Society

The annual business meeting of the Society was held at the Warner and Swasey Observatory on Wednesday, October 5. The following were nominated and elected as officers for the year 1938-39: President, Dr. J. J. Nassau, Vice-President, Mr. James L. Russell, Secretary and Treasurer, Mrs. Royce Parkin, Recording Secretary, Mr. Don H. Johnston, Executive Committee, Dr. O. L. Dustheimer, Dr. S. W. McCuskey, and the above officers. Nominating Committee, Mr. S. K. Towson, Dr. H. D. Piercy, and Mr. Royce Parkin.

Our first lecture of the fall season was held in the Physics Lecture Room of Case School of Applied Science. Subject, "Our Stone-Pelted Planet," by Dr. H. H. Nininger, Curator of Meteorites, Colorado Museum of Natural History, Denver, Colorado. Slides were used to illustrate the lecture as well as numerous meteorites and sections of meteorites. This lecture was among the most interesting ever delivered before our Society. We were astonished to learn of the large amount of cosmic matter that is deposited on the earth's surface. Also it now seems more certain that some of the craters of the moon are due to meteoric impact. That such surface indications on the earth would be erased in a comparatively short time seems reasonable but on the changeless surface of our satellite would endure for us to study as long as there is a human race. Dr. Nininger told many interesting experiences he has had in his quest for meteorites. Here as elsewhere patience seems to be rewarded. We thank Dr. Nininger for opening to us a new field for study as well as speculation. Coming lectures and lecturers are:

Dr. Robley Williams of the University of Michigan who will speak on Friday, November 18, on "The Color and Temperature of Stars." Later we will have Dr. L. J. Henyey of the Yerkes Observatory, and Dr. Bart J. Bok of Harvard College Observatory who will be our annual dinner speaker.

14 Lincoln Drive, Cleveland, Ohio. DON H. JOHNSTON.

The Joliet Astronomical Society

The Joliet Astronomical Society resumed its fall schedule of meetings on October 11, 1938, and elected the following officers: Dr. Walter B. Huey, President, Mr. Leonard Onsgard, Professor Clarence R. Smith of Aurora College, and Mr. Frank M. Preucil as Vice-Presidents in charge of the several activities of the society, Mr. Robert L. Price, Secretary and Sponsor, and Miss Alice Dombrowska, Treasurer.

At the first meeting, Dr. Huey showed colored motion pictures of an European tour taken with his family. Of special interest were the pictures of the Royal Observatory of England with its towers and time balls. The secretary opened the Joliet Junior College observatory for all who wished to see the moon and the planets then visible.

Reviews of recent books on astronomy, as well as of the periodicals of the summer months, formed the second program. Professor Smith reviewed the book, "Earth and Sky," for which he acted as editor, and the secretary reviewed "Our Starland," by Professor C. C. Wylie of the University of Iowa.

On November 8, Mr. Preucil and Mr. Ben Hur Wilson reported on their jaunt to Southern Illinois to the scene of the second Illinois meteorite at Benld where they were the first to take data on the object which struck a garage and car on September 29. After an oral report by Mr. Wilson, Mr. Preucil showed many slides of the meteorite and the damage it did. Professor Wylie who was the guest of the society for this meeting graciously consented to tell the audience of the Tilden fall of 1927.

ROBERT L. PRICE, *Secretary.*

Joliet Junior College.

The New Haven Amateur Astronomical Society

The New Haven Amateur Astronomical Society at their regular meeting on November 5 listened to reports from Mr. Neal on the Telescope Maker's Group and from Mrs. Rademacher on the recent A.A.V.S.O. meeting in Boston, the latter being very complete in detail of work done and reports made at this convention.

Dr. Ida Barney of the Yale Astronomical Staff gave a very interesting and illuminating talk on Yale's "Astronomical Star Catalogue" and said in part—

"The Yale Observatory has already published catalogs for five Astronomische Gesellschaft zones. These catalogs contain accurate positions for more than 40,000 stars and depend on the measures of star images on photographic plates covering large fields. In the case of the three catalogs first published the fields were 5°x5°, but the fields used for the later catalogs cover more than four times this area.

"The catalogs now ready for publication are for the southern sky from —10° to —20° and contain approximately 20,000 star positions. These plates were taken at the Yale Southern Station in Johannesburg with a 5-inch doublet designed by Dr. Ross of Yerkes Observatory. This objective gives excellent images over a very large field so that each one of the plates in this zone covers nearly as much of the sky as is included in the great parallelogram of Orion. Plates have been taken,

also at Johannesburg, for the zones from +9° to —2°, from —2° to —10°, and from —20° to —30°. All plates from —2° to —30° have been measured and those from +9° to —2° are now being measured in New Haven.

"For the reduction of the photographic plates it is necessary to have good meridian positions observed at nearly the same date as that at which the plates are taken. For these positions in the various zones Yale Observatory is indebted to the Lick Observatory, the Leiden Observatory, and the Naval Observatory at Washington, D. C. The number of meridian positions required depends on the size and number of the photographic plates in a zone. For the zone from —10° to —20°, Dr. Morgan at the Naval Observatory observed 1117 stars, uniformly distributed over the zone and not differing greatly in brightness from visual magnitude 8.5. Stars of this magnitude were selected because these stars give images that can be most accurately measured on the plates.

"The positions in the catalogs from —10° to —20° are the most accurate so far determined at the Yale Observatory, the probable error of one catalog position being ±0″.11 in either right ascension or declination. The corresponding probable error for the catalogs published earlier was ±0″.15. There is every reason to expect that the other catalogs to be completed in the future will have probable errors as small as ±0″.11. These positions far surpass the original Gesellschaft positions in accuracy. If weights are given in the usual way, according to the published probable errors, one Yale photographic position has more than ten times as much weight as one of the visual Gesellschaft positions."

November 17, 1938. F. R. Burnham.

The Amateur Astronomical Society of Los Angeles

The Amateur Astronomical Society of Los Angeles held its regular monthly meeting on Thursday evening, November 10, 1938, at 2606 W. 8th Street. After routine matters had been disposed of, the president, Dr. Mars F. Baumgardt, gave a brief outline of the early history of the satellites of Jupiter, followed by the introduction of the speaker of the evening, Dr. Seth B. Nicholson of the Mount Wilson Observatory.

Dr. Nicholson had chosen for his subject, "The New Satellites of Jupiter." These interesting objects, discovered by the speaker with the 100-inch telescope last August, are of magnitude nineteen, corresponding to a diameter of about 15 miles. The search photographs, made with an exposure of one hour at the Newtonian focus of the 100-inch, showed about forty moving objects, of which six were satellites of Jupiter. It is interesting to note that the orbit of Jupiter X corresponds closely with those of Satellites VI and VII, so that they form a curiously connected group. Jupiter XI also forms a triplet system with Satellites VIII and IX, all pursuing retrograde paths. The period of Jupiter X is about 260 days; that of Jupiter XI about 690. Dr. Nicholson illustrated his remarks by wire models of the relative orbits of the moons of Jupiter, and also by lantern slides and drawings. He provoked amusement in his audeince by the statement that he was surprised that he had not found five or six more moons! Dr. Nicholson is a fine speaker, constantly holding his listeners' attention by his highly interesting and informal style.

The meeting adjourned after announcement of an excursion to Mount Palomar Observatory the following Saturday.

On November 12 a party of about thirty members and friends motored to

Mount Palomar, 140 miles by road from Los Angeles. By the courtesy of Dr. J. A. Anderson, executive officer of the Observatory Council of "Caltech," the society was allowed to inspect the dome of the 200-inch reflector. The dome itself is practically completed, work having begun on securing in place the heavy castings at the north and south piers. The south end of the yoke was in place. The dome, 136 feet in diameter, has as its base a large block of concrete, going down thirty feet where, on a thick pad of cork, it rests on bedrock. Our tour of the 200-inch dome was under the guidance of Messrs. Hill and Marshall, and after inspecting the powerhouse and the partially completed dome for the 48-inch Schmidt camera, we were conducted by Dr. J. J. Johnson through the small dome housing the 18-inch Schmidt camera. This is the famous little telescope with which Dr. Fritz Zwicky of Caltech has found several supernovae.

By this time the sun had set, and the temperature dropped to about ten degrees below freezing. The group broke up after dark, and returned to the city. In addition to the Los Angeles group, amateurs were present from the Riverside and San Diego societies, including Mr. H. A. Lower of Schmidt camera fame.

Elsinore, California. GEORGE HERBIG, *Secretary.*

The Amateur Astronomical Association of Des Moines

A group in this city recently formed an association, to be known as The Amateur Astronomical Association of Des Moines. The following officers have been elected: A. E. Chennell, President; P. R. Engle, Vice-President; C. O. Davis, Secretary; E. Jensen, Treasurer; Board of Directors, Clifford Beamer, Hugh E. Johnson, Margaret Black.

Meetings are to be held once each month and we feel that we are indeed fortunate to have the privilege of using the Drake University Observatory for these meetings with the kind consent of Dr. Morehouse, President of Drake University and internationally known astronomer. In this connection we also have Dr. Theo. Mehlin to act as our leader and while this Association has no connection whatever with Drake University, Drs. Morehouse and Mehlin have consented to lend assistance to the group. We will have access to the 8-inch refractor after these meetings which will mean something to most of us, even though a number of us have our own home-made telescopes and get excellent results with them.

Drs. Morehouse and Mehlin have been made honorary members of this Association. We hope to grow from our present fifteen members to many more in the near future. C. O. DAVIS, *Secretary.*

Des Moines, Iowa, November 21, 1938.

The Revolution Period Law

While speculating upon the possible physical basis of Bode's law, I recently discovered a relationship between the periods of revolution of the bodies of the solar system which is certainly of fundamental importance. The relationship is so consistent, and so simple mathematically, that it is entitled to be designated as a law.

It is apparent that Bode's law is in reality a relationship between the revolution periods, since the mean distances of the solar bodies are computed from the formula

$$D = P^{2/3}$$

where D is the mean distance of the body from the sun, with the distance of the

earth taken as the astronomical unit, and P is the sidereal period of revolution of the body around the sun in years. This is Kepler's third law, and when the distance from the earth to the sun is computed in miles from its parallax or by other means, it makes possible the computation of the distances of all other bodies except the moon.

The bodies of the solar system are numbered consecutively outward from the sun, with the sun as zero, Mercury as number one, Venus as number two, the earth as number three, and so on to the outermost known planet, Pluto, as number ten; the asteroids are included as number five. When these planet numbers are plotted against their periods of revolution as seen against the background of the stars, it is immediately apparent that regular mathematical relationships exist between the two quantities.

The curve divides naturally into three sections, with the earth and Uranus marking the divisions between them. In section number one, which extends from the sun through Mercury and Venus to the earth, the sidereal period curve is a straight line. In section two, extending through Mars, the asteroids, Jupiter, and Saturn, the curve is logarithmic, or exponential, in form. The curve for section three, extending from Uranus through Neptune to Pluto, is a straight line.

Equations were derived for each of these curves, by means of which the sidereal period of each planet can be computed directly from its planet number. In the equations y represents the planet numbers, and P the sidereal periods.

The three equations are:

$$\text{Section I} \quad y = 2.641\,P + 0.365 \tag{1}$$

$$\text{II} \quad y = 2.51 \log P + 3.31 \tag{2}$$

$$\text{III} \quad y = 0.01225\,P + 6.97 \tag{3}$$

The first equation is that of a straight line which does not pass through the origin, the origin being represented by the sun.

The planet numbers of the planets included in the second section are a logarithmic function of the sidereal periods. The calculated average period of the asteroids is 4.716 years, which is equivalent to an average distance of 2.81 astronomical units from the sun.

The third equation shows that the planet numbers of the planets from Uranus outward are a linear function of the sidereal periods. The sidereal period of a possible planet number 11 beyond Pluto is calculated from the equation as 329 years, equivalent to a distance of 47.67 astronomical units from the sun.

The observed and calculated periods are compared in Table I. The largest deviation obtained from the observed values is 0.75 percent, and the average is

TABLE I—PLANETS

Position Number	Name	Sidereal Period in Years Observed	Calculated	Percent Deviation
0	Sun	...	...	...
1	Mercury	0.2410	0.2404	—0.25
2	Venus	0.6155	0.6190	+0.57
3	Earth	1.000	0.997	—0.30
4	Mars	1.881	1.883	+0.11
5	Asteroids	...	4.716	...
6	Jupiter	11.86	11.80	—0.50
7	Saturn	29.46	29.51	+0.17
8	Uranus	84.02	84.1	+0.10
9	Neptune	164.78	165.7	+0.56
10	Pluto	249.17	247.3	—0.75
11 (?)	.....	...	329.0	...

about 0.3 percent. A more nearly exact evaluation of the constants of the three equations would no doubt reduce the deviations, but this tabulation is sufficient to show the order of accuracy of the law.

The investigation was extended to include the satellite systems of Jupiter, Saturn, and Uranus, and it was found that the same general relationship holds between the body number and the revolution period. However, in these systems the number was found to be a logarithmic function of the period in every case, instead of a linear function.

The satellites were numbered consecutively outward from the planet, with the planet as zero, the nearest satellite as number one, and so on. The period of a satellite near the planet was taken as the unit period for that system, and the periods of all other bodies expressed in terms of the unit selected were plotted against their position numbers.

The systems of Jupiter and Saturn were found to require two equations each, while Uranus, with only four satellites, required only one equation. In four instances two adjacent satellites were found to occupy one position number, with the adjoining position number vacant. In only one instance was a satellite definitely out of line, that being Jupiter's nearest satellite.

Jupiter

In the Jupiter system the revolution period of the satellite Io in the second position was selected as the unit value, and the periods of the other satellites were calculated in terms of this unit. The four inner satellites followed one functional law, while the outer ones including Callisto required a different expression. Satellite V in position number one was definitely out of line. No satellite was found in position number six, while the average period of satellites VI and VII fitted approximately into position number seven, and satellites VIII and IX into position number eight. The periods of satellites X and XI were not available.

Equation (4) is that of the nearer satellites, and equation (5) includes those from Callisto outward.

$$y = 3.30 \log P + 2.00 \qquad (4)$$

$$y = 1.75 \log P + 3.30 \qquad (5)$$

The periods computed from the equation are compared with the observed periods in Table II.

TABLE II—Jupiter System

Position Number	Name	Revolution Period: Days Obs.	Revolution Period: Io = Unity — Observed	Revolution Period: Io = Unity — Calculated	Percent Deviation
0	Jupiter	...	...	0.2478	....
1	V	0.498	0.2814	0.498	+76.9
2	Io	1.769	1.000	1.000	0
3	Europa	3.551	2.007	2.009	+ 0.10
4	Ganymede	7.1544	4.044	4.075	+ 0.82
5	Callisto	16.689	9.43	9.38	— 0.53
6	(Missing)	...	...	35.0	...
7	VI and VII	255.37	144.4	130.	—10.0
8	VIII and IX	742.	419.5	485.	+15.6

It is seen from these results that equation (4) gives the revolution periods of the inner bodies with exactness, except for satellite V, which is definitely an exception to the rule. Jupiter was given the position of zero, and its average period of rotation computed as 0.438 day, or 10.5 hours. This result compares reasonably well with the observed minimum period of rotation of 9 hours 55 minutes.

Equation (5) does not check the observed periods of the outer bodies as exactly as the other equations. This may be caused by the fact that two of the three occupied position numbers are occupied by pairs of satellites, and their true period may be somewhat different from the numerical average of the two bodies.

Saturn

The Saturn system is more regular than that of Jupiter, since its nine satellites include no outstanding exception to the revolution period law. The period of Mimas, the satellite nearest to Saturn, was selected as the unit value, and when the periods of the other satellites were computed in terms of this unit and plotted against the satellite number, two regular logarithmic curves were obtained, having the same general pattern as those of Jupiter.

Like Jupiter, the first four position numbers were included in the inner series, but unlike Jupiter they were completely regular. The outer series beginning with Rhea included the remaining satellites, with position six vacant, position seven occupied by both the sixth and seventh satellites, and position eight vacant. The eighth satellite occupied position nine, and the ninth satellite position twelve.

Equation (6) is that of the four inner satellites, and equation (7) includes those from Rhea outward.

$$y = 6.50 \log P + 1.00 \quad (6)$$

$$y = 3.30 \log P + 2.75 \quad (7)$$

The periods computed from the equations are compared with those observed in Table III.

TABLE III—Saturn System

Position Number	Name	Revolution Period: Days Obs.	Revolution Period: Mimas = Unity — Observed	Revolution Period: Mimas = Unity — Calculated	Percent Deviation
0	Saturn	...	...	...	....
1	Mimas	0.942	1.000	1.000	0
2	Enceladus	1.372	1.457	1.425	— 2.24
3	Tethys	1.888	2.003	2.032	+ 1.45
4	Dione	2.738	2.905	2.894	— 0.38
5	Rhea	4.517	4.794	4.809	+ 0.31
6	(Missing)	...	...	9.66	...
7	Nos. 6 and 7	18.610	19.75	19.415	— 1.70
8	(Missing)	...	...	39.0	...
9	No. 8	79.33	84.02	78.44	— 6.84
10	(Missing)	...	...	157.4	...
11	(Missing)	...	...	316	...
12	No. 9	550.44	584.5	632	+ 8.13

Uranus

The Uranus system contains only four satellites, whose observed periods agree very closely with those computed from the law. The first and second satellites occupy the first and second position numbers, respectively. The third position number is vacant, and the average period of the third and fourth satellites, Titania and Oberon, occupies position number four. The period of the satellite Ariel, which is nearest to Uranus, was selected as the unit value.

Equation (8) is that of the four satellites:

$$y = 4.67 \log P + 1.00 \quad (8)$$

The periods computed from equation (8) are compared with those observed in Table IV.

TABLE IV—URANUS SYSTEM

Position Number	Name	Days Obs.	Revolution Period — Ariel = Unity — Observed	Calculated	Percent Deviation
0	Uranus	...	...	...	....
1	Ariel	2.520	1.000	1.000	0
2	Umbriel	4.144	1.643	1.639	— 0.24
3	(Missing)	...	...	2.682	...
4	Titania and Oberon	11.085	4.400	4.400	0

DISCUSSION OF EQUATIONS

The equations are all expressed in the straight line form

$$y = mx + b$$

where y is the position number, m is the slope of the line, x is either the logarithm to the base 10 of the period (P) or the period, and b is the numerical value of the y intercept.

It is noticeable that many of the values of m and b in the equations can be expressed almost exactly as fractions composed of small numbers, and when this is done they take the following forms:

System	Position No. as 1		
Solar I	3	$y = 66/25\ P + 11/30$	(1a)
II	3	$y = 5/2 \log P + 10/3$	(2a)
III	3	$y = 3/245\ P + 7$	(3a)
Jupiter I	2	$y = 10/3 \log P + 2$	(4a)
II	2	$y = 7/4 \log P + 10/3$	(5a)
Saturn I	1	$y = 13/2 \log P + 1$	(6a)
II	1	$y = 10/3 \log P + 11/4$	(7a)
Uranus	1	$y = 14/3 \log P + 1$	(8a)

The logarithmic equations may all be expressed in this form:

$$P = (10)^{(y-b)/m}$$

and

$$D = (10)^{\frac{2}{3}(y-b)/m}$$

where P is the period of revolution and D is the distance from the central body, both in terms of the unit selected for each system.

SUMMARY AND CONCLUSIONS

It has been shown that if the planets or satellites are numbered consecutively outward from the central body about which they revolve, their periods of revolution conform to regular mathematical functions of their position numbers. This relationship has been named the Law of the Revolution Periods.

For all of the satellite systems investigated the position number was a logarithmic function of the revolution period. The function was also logarithmic for the central planets from Mars to Saturn inclusive, but linear from the sun to the earth and from Uranus to Pluto.

The distances from the central body are also functions of the position numbers, since the distances are calculated from the periods by the formula:

$$\text{distance} = (\text{period})^{2/3}.$$

The approximate relationship known as Bode's law is a result of this conformity.

With one or two exceptions, the deviations from the revolution period law are small, averaging well under one per cent.

The planet system includes three sections with different functions, while the

satellite systems include only two or one. In all cases the revolution period increases more between successive number positions in the outer sections than in the inner section.

The law makes possible the computation of the periods and distances of undiscovered bodies.

Both the revolution periods and the distances may be expressed as ten raised to the power of small integral functions of the position numbers.

The complete interpretation of the physical meaning of the revolution period law remains to be made. However, there can be little doubt but that it is an expression of the effects of the force field, or potential field surrounding each central body. The analogy of the position numbers with the electron orbits around the nucleus of an atom is striking, but considerable mathematical research will be required before a definite relationship can be established.

FRED C. BOND.

1645 South 80th Street, West Allis, Wisconsin.

General Notes

Brian O'Brien, Ph.D., Professor of Physiological Optics, University of Rochester, Rochester, New York, lectured before the Franklin Institute, Philadelphia, Pennsylvania, on Thursday, November 10, 1938, on the subject: "Detection and Consequences of Variability of the Sun."

American Astronomical Society

At the invitation of Professors Jan Schilt and W. J. Eckert, the sixty-first meeting of the American Astronomical Society will be held at Columbia University, New York City, December 29 and 30, 1938. These dates will avoid conflict with the meetings of Section D of the American Association for the Advancement of Science, which will meet at Richmond, Virginia, December 27 and 28.

Section D (Astronomy) of the A. A. A. S.

The American Association for the Advancement of Science is holding its scheduled meeting this year at Richmond, Virginia, December 27-31. Meetings of the astronomical section (D) are scheduled for Tuesday and Wednesday, December 27 and 28. The Tuesday afternoon program will be devoted to a joint session of Sections D and E for a symposium arranged by Section E and the American Geophysical Union, in which important problems relative to the earth sciences will be presented.

There will be general sessions for contributed papers on Wednesday morning and afternoon. The Wednesday morning program will include the address of the retiring Vice-President of the Section, Dr. Philip Fox of the Museum of Science and Industry, Chicago. Through the invitation of Professor S. A. Mitchell, Director of the Leander McCormick Observatory of the University of Virginia, there will be opportunity for those attending the Section D sessions to visit the observatory. Plans are being made for a dinner of the section. It is anticipated that this will be held at the Jefferson Hotel at six o'clock on Tuesday evening, December 27.

HARLAN T. STETSON, *Secretary,* Section D.

The Rittenhouse Astronomical Society of Philadelphia held its regular monthly meeting on Friday, November 11, at 8:30 P.M., in the Hall of The Frank-

lin Institute. The program was a symposium commemorating the bicentenary of the birth of Sir William Herschel (November 15, 1738-August 25, 1822), with contributions by Mr. Frederick E. Brasch, Secretary of the History of Science Society and Librarian of the Smithsonian Division of the Library of Congress, Mr. Edwin F. Bailey, Amateur Telescope Maker, Dr. Samuel G. Barton, Associate Professor of Astronomy, The University of Pennsylvania, and Professor Henry V. Gummere, Director of the Strawbridge Observatory, Haverford College.

The Steward Observatory Fellowship

It is expected that the Steward Observatory Fellowship at the University of Arizona will be available for the academic year 1939-1940. The stipend of the fellowship is $450, and the payment of the tuition fee is waived. The fellow is expected to assume certain moderate duties, chief of which is assistance with photoelectric observing about two half-nights per week.

There will be opportunity for formal courses, and, more especially, for rather extensive use of the 3-foot reflector. The observing equipment is especially adapted to photometric investigations, either photoelectric or photographic. The photoelectric photometer is described briefly in the *Astrophysical Journal*, **88**, 305, 1938. Both visual and physical photometers are available for measuring photographic plates.

It has become the custom to appoint to the fellowship a student who plans to spend his time almost exclusively in gathering observational material for his doctorate thesis at another institution, on a problem of his own choosing, and preference will be given to those who apply under this plan. Applications should be directed to Professor E. F. Carpenter and should be received by March 1, 1939.

Correction.—The last two sentences at the bottom of page 423 (October issue) should read, "He came to Beloit, Wisconsin, in 1850. His son, William Ellery Hale, who was born at Bradford, Massachusetts, accompanied him. Later the family returned to the East. William Ellery Hale came west to Chicago in 1863, shortly after his marriage."

Correction.—On page 301 of the June-July issue, line 8 from bottom, the credit for taking the discovery plates of the satellite Phoebe should be ascribed to Dr. DeLisle Stewart who was working under instructions from the Harvard College Observatory.

Change of Date of issue of Popular Astronomy.—Beginning with the new year the several issues of this magazine will be mailed as near the twenty-fifth of the preceding month as possible instead of on the first of the month of issue as has been the case. It is hoped that the subscribers will then have their copies on or near the first of the month.

Contributors are respectfully requested to note this change of schedule and, if possible without too great inconvenience, to dispatch their contributions so as to reach this office by the fifteenth of the month at the latest.

CURVIN H. GINGRICH, *Editor.*

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